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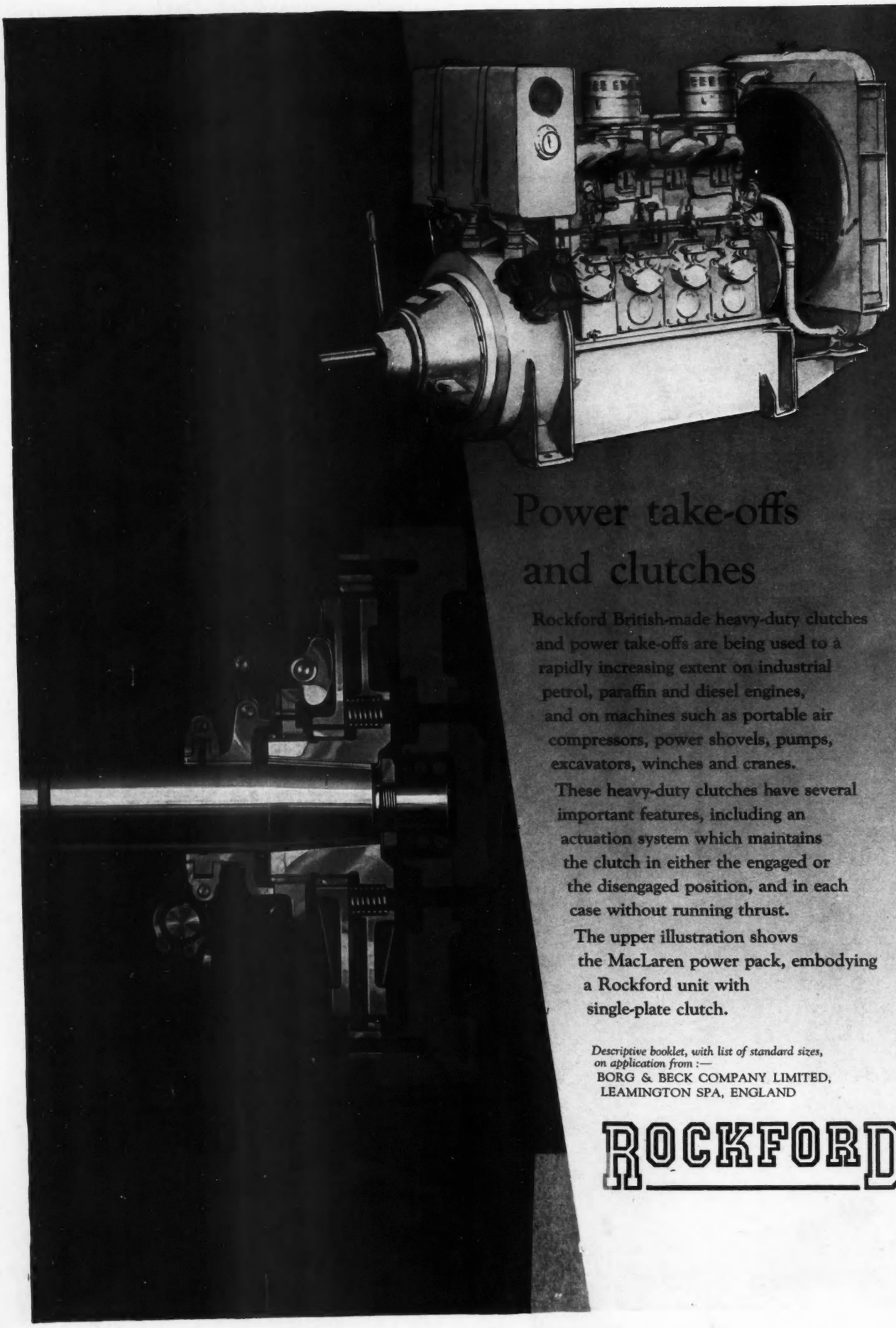

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An Illustrated Weekly Journal

Vol. 179 No. 4641 JANUARY 7, 1955

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WITH OPEN EYES

TEN years ago few people had heard of atomic energy; probably as few had heard of Hiroshima. Then in one destructive moment the formulae of physicists assumed material form and the power hidden in the atomic nucleus became the world's first topic and its most grave concern. But in recent years atomic energy has been applied to peaceful purposes and it is now recognised not only as a means of destruction but also as a source of vast wealth. The prospect of riches and the possibility of extinction are thus linked factors in the heritage of the growing generation, and it is on these young people that the control of this most formidable power will depend. It might therefore be valuable to learn their views, however inexperienced, on the future course of technological development, in which atomic energy must play so large a part.

Evidence of interest in nuclear technology was plentiful at the Christmas Lecture for Older Schoolchildren held on December 30 and December 31, 1954, at the Institution of Electrical Engineers. The lecturer on this occasion was Dr. T. E. Allibone, D.Sc., M.I.E.E., F.R.S., and his subject "Nuclear Power—Electricity from Uranium". Ingenious models and short films helped to make the lecture both absorbing and amusing. When he had finished speaking Dr. Allibone invited questions from the audience, and many of the questions submitted by both boys and girls tended to reveal erudition, rather than ignorance, in the field of atomic physics.

Nine of those who had asked questions remained afterwards to give their views on the future of technology; their ages ranged from 13 to 18. Of these, two planned to be engineers, one in electronics and the other in aeronautics; two intended to take up teaching; one proposed to enter medical practice; and the remainder hoped to find careers in a branch of pure science. Seven of them had scientific hobbies.

The discussion was characterised by optimism and belief in technological progress. Not one considered that the world would be a better place without aeroplanes, atomic energy or television; with or without these ambiguous gifts men should, with God's help, be able to control their destiny, and surely it remained within the scope of human prerogative to switch off!

It was also suggested that if peace could be harnessed in some way to personal desires and ambitions, as individual reward had been linked to the production of manufactured goods, there would be less tendency to misuse scientific discoveries. In any case, few tools or implements could be safely used without caution.

It was considered that the future of technology would be associated with the development of automatic machines but that there would nevertheless be an increasing demand for engineers. Engineers needed both a broad education and practical experience, and it was pointed out that since engineers were the servants of mankind they ought to know its history. The engineer was a respected member of the community but perhaps received less recognition than other professional men because he had less contact with the man-in-the-street. However, all people were dependent one on another as, for example, were the stomach and the hands. The discussion ended with an assertion that technologists would in the future play an increasing part in human affairs.

Engineers and technologists are now taking the place of scientists as custodians of atomic energy, and it is to future engineers that we must look for its safe keeping and its benefits. Theirs is the power to convert energy to profitable use and natural energy is the ultimate source of all material civilisation. Thus it was pointed out by Dr. A. Parker, in the 36th Thomas Hawksley Lecture to the Institution of Mechanical Engineers (ENGINEERING, vol. 168, page 688, 1949), that in terms of the energy available per head of population, each inhabitant of Great Britain possessed the man-power equivalent of approximately 15 slaves. In the United States at that time the corresponding figure was 27. Atomic energy can increase this number. A leisure like that of ancient Athens, but slaveless, may therefore lie ahead.

The validity of this encouraging prophecy is perhaps open to question, but whatever bounty atomic energy may yield, there can be little doubt that it places new possibilities within the reach of man. Territories at present undeveloped for want of local fuels or power may become rich, and barren areas fruitful, as, for example, may the deserts of Australia and Africa, and even the Antarctic wastes.

Tomorrow's generations must increasingly depend for their standard of life on present investment in backward countries, and especially closely is Britain's future linked with the development of regions within the Commonwealth. Expanding populations and diminishing stocks of natural resources in certain parts of the world add to the urgency of the situation and underline the need for measures of this kind. Atomic energy can be the means by which they are put into practice, and those now at school may be the first to gather the rewards.

Young people of to-day are advancing towards this future with open eyes; they are aware of pitfalls, know there are dangers to be faced, but are well prepared to meet them. They, at least, have learnt the lesson of ten years ago. What of ten years hence?

Weekly Survey

Cover Picture: *The work of the foundry has been changed in recent years by the advent of new techniques, particularly for small castings, and has had to meet the competition of welded fabrication. But the crafts of the patternmaker and moulder are still indispensable to the engineering industry. The front cover shows a pattern for a pinion-housing cap.*

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1954 TO 1955

The first of the 1955 Engineering Outlook articles appears in this issue (on page 10). In it the production and trade of the engineering industry are analysed and discussed. The article will be continued next week by an examination of the raw materials situation and a discussion of the impact on suppliers of engineering materials, such as steel, copper, nickel and iron castings, of the rapid expansion of certain branches of engineering, such as motor-cars, electric household appliances and aircraft. A third general article will discuss the manpower situation and any implications the level of wages may have on companies' capital investment policy. Ten subsequent articles will deal each with one branch of engineering: agricultural machinery, the machine tool industry, the rolling stock industry, and so on. This annual series of articles was started over 20 years ago to provide a retrospect of the main events of the old year and an assessment of the economic outlook for the year ahead.

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ENGINEERING PRODUCTION PROSPECTS

The year 1954 has proved much better than most manufacturers had hoped at the outset. The output of engineering products rose by more than the 7 per cent. rise in industrial production, and that of certain branches of the industry substantially more than this. The largest increase, which was in the output of motor-cars, may well prove to have exceeded 25 per cent., and the increase in the output of electric household appliances is unlikely to have been much less.

The most significant feature of British industrial development in 1954 has, in fact, been the vast amount of money spent by the home consumer on durable goods—cars, washing machines, refrigerators, radio and television sets, vacuum cleaners, etc. This trend, which is only beginning to assert itself, may well alter the fundamental character of our engineering industry, as it did that of the United States. The implications are fairly clear, and far reaching: mass production of standard articles (any departure from standard would be economically almost impossible) making necessary an extensive use of special machines, mechanical handling and automatic controls, requiring very large quantities of sheet steel, electric motors, non-ferrous and plastic components. The requirements of skilled labour would fall, except for tool-making, tool-setting and machine maintenance, yet dependence on labour would tend to increase as stoppages of expensive plant are very costly. The need to keep machines operating at high speeds and production lines moving quickly would tend to outweigh the importance of low labour costs and wages would probably rise substantially. In fact high wages and a high standard of living are a *sine qua non* of this type of development.

The article on page 10 points out that the prosperity of 1954 was not Britain's alone, but was shared by all major European countries, although it is difficult to relate performances, as conditions are rarely comparable. The estimate of a 4 per cent. increase in investment in plant and machinery suggests that industry is lagging behind its own productive effort in equipping itself with modern machinery, or—more probably—that in 1953 many factories and machines were under-employed. There is, however, little slack remaining, and any rise in industrial production in 1955 must therefore come from the commissioning of new factories and the extensive re-equipping of old ones. One might say that rising output can only be maintained in the wake of an expanding production of cars and household appliances.

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THE PROBLEM OF EXPORTS

The major problem of British engineering in 1955 will be to maintain its production for export at the same proportion as last year, or to increase it to compensate for a likely adverse change in the terms of trade and higher imports of certain materials.

Higher imports are the inevitable accompaniment of a high standard of living in this country, which is the mainspring of a continued rise in engineering output and entails more housing, better roads, more expenditure on welfare, more food—in short, more consumption. Investment will follow, since the goods cannot effectively be produced with old plant, but exports will not automatically increase, or even be maintained in the face of increasing foreign competition at a time when selling at home becomes more and more profitable. This is the danger in 1955, and if it is heeded the year should prove one of the most prosperous in the country's history. One of the most heartening signs that British engineering products may well increase their sales overseas is the recent decision of the U.S. car manufacturers, General Motors and Ford, to expand production in the United Kingdom in order to supply all those areas where the dollar is likely to remain scarce for many years. There is nothing to stop washing machines, refrigerators and other mass-produced British goods from following where cars have led.

Some U.S. manufacturers have already found that their British-made products can even compete effectively in dollar markets with their U.S. made products; the recovery of the American economy from recession should thus provide an opportunity for increased British dollar earnings. Unfortunately, conditions have deteriorated in some Commonwealth markets, notably Australia, where falling wool prices may lead to a fall in imports from the United Kingdom.

Increased exports to Europe might well compensate for any such fall; it is most encouraging that in 1954 British manufacturers made considerable progress in the European markets where they have been exposed to the full force of German competition. The ability to meet competition depends, of course, upon keeping down costs and this may not be easy if too much attention is paid to the lucrative home market. The present boom, which is already based rather too much upon buoyant home sales, has necessarily caused demands for higher wages. Though we have argued that these are not undesirable in themselves, there is a danger of inflation; unchecked, this would mean not only falling exports but the collapse of home demand.

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STEEL SUPPLIES

The year 1954 proved very successful for the British iron and steel industry, though the progress made was somewhat uneven. Heavy demand for sheet and plate was mainly responsible for raising the total output of ingots and castings from 17·6 million tons in 1953 to 18·5 million tons in 1954. Output of light rolled products, forgings, castings and high-speed steel actually fell. This is due partly to factors such as the decline in re-armament orders and the uneven growth of the various consuming industries, the effects of which are likely to be persistent. It was accentuated by the exceptional slackness in demand early in the year when some plants producing bars and wire rods were working well below capacity. About mid-year, when orders began to come in more rapidly, there was difficulty in recovering labour; in some cases shortages developed necessitating marginal imports, which may be needed for some months if pressure of demand continues. In the case of tin-plate, it was found necessary to suspend the import duty in November to enable the principal producers to obtain the extra quantities needed. Despite an increase in sheet production of 15 per cent. and curtailment of exports, it was necessary to import 175,000 tons.

In 1955, the addition of new capacity will eliminate many of the shortages. Development work at Margam, Ebbw Vale and Shotton, for example, will mean an increase of 10 to 15 per cent. in sheet and tin-plate production. The difficulty over plate supplies has already been overcome, and the shipbuilding industry should go on in 1955 to achieve a new post-war record.

Output of ships in 1954 reached 1·5 million gross tons, the highest since the war. Despite the increased output there are now signs that the order book, which is now about 4·25 million gross tons, has ceased to decline. Orders booked in the last quarter of 1954 amounted to 300,000 tons.

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INDIAN STEEL CAPACITY

In the Weekly Survey for September 10, 1954, it was pointed out that if the Indian five-year plan for steel production is to be fulfilled, additional plant capacity is likely to be required as well as that for which preliminary plans have already been approved in collaboration with the German consultants, Krupps and Demag. It will be recalled that output by 1958 is scheduled to reach 2,250,000 tons compared with actual production in 1953 of 1,470,000 tons.

Now a British company has decided to offer to build a large steel plant for the Indian Government for which the equipment will cost about £45 million. The company concerned is the Metallurgical Equipment Export Company, Limited, whose offer earlier last year to Mr. B. M. Birla, the Indian industrialist, was turned down by the Indian Government because private ownership of new iron and steel plant is contrary to Indian industrial policy. Russia is also reported to have offered to supply India with steel-making plant, but although Russian technicians are now in Delhi no details of the offer have been made public, beyond the fact that the financial terms are said to be attractive and the promised delivery date unequalled. It is believed that another offer has already been made by French interests and that United States companies may also enter the field.

Detailed designs and specifications for the German project, which is designed for an initial output capacity of 500,000 tons, are expected to be ready early this year, but it is estimated that the plant will take at least four years to come into production. During this period output from the existing producers, the Indian Iron and Steel Company, Limited, and the Tata Iron and Steel Company, Limited, is expected to increase by about 650,000 tons, with the result that by 1959 output capacity should exceed 2,500,000 tons. The need for any further increase will depend mainly on the rate of progress achieved in the second five-year plan, which lays particular emphasis on general industrial and engineering expansion. Although the long-term goal is said to be a four-fold expansion, i.e., to about 6 million tons, it would seem to be unlikely that the Indian Government will approve more than one additional scheme for the time being. Although full details of the British offer are not yet available it is understood that attention has been paid to future development, and in particular to expansion in the processing sections of the industry. That progress is being made in the steel-consuming industries is shown by the recently issued report of the Indian Planning Commission, which covers the first three years of the five-year plan. Thus, in 1953-54 the country produced 86 locomotives and 289,000 bicycles, and is exporting some engineering products such as sewing

machines. Although only a relatively slow start has been made in the production of motor vehicles, a number of components are now made in India and plans are in hand for the production of motor cycles and commercial vehicles as well as private cars.

The ultimate decision as to which of the various offers will be accepted will obviously have a very important influence on the future of international trade in steel plant machinery. In the case of the German project the Indian Government hopes to place orders for plant and equipment by inviting open tenders, but since the preliminary proposals of the German consultants are based on a process which is standard practice in Germany, and the amount of German investment in the scheme is geared to the amount of plant bought in Germany, it appears inevitable that a high proportion of the equipment will be bought from that country.

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TRAINING ENGINEERS FOR UNDER-DEVELOPED COUNTRIES

A one-year course in " environmental engineering and resource utilisation "—"civil engineering " in plain language—is to be inaugurated at Glasgow Royal Technical College, to give engineering graduates with a good honours degree the background knowledge that they will require to tackle the problems of the underdeveloped countries such as those covered by the Colombo plan. The course, which is to begin in October, 1955, is expected to attract post-graduate students from many parts of the world.

The greater part of the initial cost is to be met by a grant of £24,000 from the Rockefeller Foundation, who are also contributing 10,000 dols. towards the expense of the first five years. The college will assume full responsibility for the course, which will be run by the Department of Civil and Mechanical Engineering under Professor Adam S. T. Thomson. Graduates attending the course will be trained to integrate their work in water supply, drainage, housing and communications with public health, power development, mining, agriculture and forestry requirements. Throughout the course the conservation of resources will be emphasised, particularly such problems as the recovery of minerals from sewage and other wastes, arid-zone hydrology, and soil erosion.

The course will include visits and field studies, for which Glasgow is considered to be well placed, as a valuable range of field and regional studies can be organised within easy travelling distance. The activities of the North of Scotland Hydro-Electric Board, ranging from hydro-electric stations to crop drying and the development of peat-burning gas-turbines, and of the Forestry Commission, will be extremely apposite to the purpose of the course. The course will be invaluable in producing men who could exert a beneficial influence on behalf of the United Kingdom in countries overseas.

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PROSPERITY IN SCOTLAND

Engineering accounts for about 10 per cent. of the labour force in Scotland and about 5 per cent. of it is occupied directly on shipbuilding. This industry is still the key to Scotland's prosperity, despite the efforts in the last generation to diversify the industrial structure. The engineering boom which has gathered impetus throughout the United Kingdom in 1954 has been marked in Scotland by the highest level of launchings in peace-time since 1929. The Clyde shipyards launched 477,800 tons of shipping in 1954 and this is about 79,000 tons more than in 1953. Over and above this, there is a useful volume of naval work, which last year included two frigates and several coastal minesweepers and seaway defence boats.

The high level of launching was not accompanied by a corresponding increase in the flow of new orders. Work on hand will keep the yards fully occupied for one to two years but the cancellation of several tanker orders has underlined the fact that the boom in tanker building which has stood the shipbuilding industry in good stead since the end of the war is now virtually at an end. There is some encouragement to be gained from the fact that a flow of orders for small vessels and cargo ships is now reaching the yards but it is an increased flow of orders for this kind of tonnage which the shipyards must obtain if their prosperity is to be ensured in the late 1950's.

Lord Rowallan drew attention in his address at the annual meeting of the National Bank of Scotland, of which he is Governor, to the significance of the North of Scotland Hydro-Electric Board. In his view, the Board's projects were not fully appreciated. There is no doubt that this is an engineering development which may bring cheap power to some areas (though not to all) with a stimulating effect on new industries in Scotland. It is also true that Scotland has staked a claim on the future of atomic development with the new plant at Dounreay. These, particularly the latter, are developments whose significance the future alone can unfold.

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AIR TRAFFIC IN 1954

In common with a number of other international airlines the British European Airways Corporation had a very successful year in 1954. Provisional figures for the year given by the chairman, Lord Douglas of Kirtleside, show a traffic increase of about 18 per cent. compared with 1953, while the deficit, which stood at £1·7 million at the end of 1953, was reduced by about £1 million. The number of passengers carried was 1,825,000, in addition to 14,450 tons of freight and 6,900 tons of mail. He went on to say that in their first year of service in the Corporation the Viscount air-liners had carried 335,000 passengers and their achievements, coupled with the service of information provided by B.E.A. to prospective purchasers, had had a strong influence on overseas orders, particularly the order for 60 Viscounts placed by Capital Airlines of the United States.

A comparison of the B.E.A. figures with those issued by the International Air Transport Association and the International Civil Aviation Organisation covering the progress of civil aviation throughout the world show that B.E.A. has fared rather better than the average. The I.C.A.O., whose statistics cover small operators as well as large, reports an increase in total passenger mileage in 1954 of 12 per cent. compared with 1953. The year was remarkable for the achievement of new records in practically every category of airline traffic and in particular it was the first year in which the number of passengers crossing the oceans of the world by air exceeded the number travelling by sea. Another important new development was the opening by the Scandinavian Airlines System of a regular air service over the Arctic between Europe and Los Angeles.

The I.A.T.A., which is concerned with the international airlines and has 71 members, reports that the combined turnover of their members reached £714 million, representing nearly 90 per cent. of the world's total scheduled air transport business excluding Russia and China. The total number of aircraft involved was over 2,500.

Certain features of the reports draw attention to the need for caution in assessing future prospects. In both passengers and freight the rate of expansion was less than in previous years, though in the case of passengers the difference was not serious. In freight, on the other hand, the increase in traffic was only 4 per cent., compared with 8 per cent. in the previous year and 20 per cent. in 1952. There has been a fall in cargo rates and much of the expansion in passenger traffic has been due to greater use of the cheaper tourist services, with the result that, according to Sir William P. Hildred, chairman of I.A.T.A., net profits after payment of taxes are " dangerously low." The industry is therefore very vulnerable to the effects of any recession in trade or travel or increases in costs or taxes.

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NICKEL REPORT

The end of restrictions on nickel by the Governments of the United States, Canada and Great Britain did not result in ample supplies for all users (a point which was remarked upon in a leading article in our issue of November 5.) Now the latest information on nickel supplies holds out little prospect for improvement in the immediate future.

Canada supplies about 80 per cent. of the free world's nickel and, although production is expected to increase, the rate of expansion will probably slow down in 1955, after a quick upward movement in 1954. Production in Canada was 286 million lb. in 1953, and will probably have been about 320 million lb. in 1954, compared with an estimate of 332 million lb. in 1955. Much of the stimulus to increase output has come through Government premium prices, and output is now running about 50 per cent. higher throughout the free world than before the Korean war. But this increase is being absorbed in Government stockpiles and only a small amount of the additional production reaches civilian users despite a lessening in the arms programmes. So far as the applications of nickel are concerned, the steel industries of the U.S., the U.K. and Canada continue to absorb most of the primary nickel distributed to industry for use in stainless steels, engineering alloy steels and jet-engine alloys. In the United States, the production of chromium-nickel stainless steels in 1954 is thought to have been about the same as in 1953, and engineering alloy steels fell off slightly, but alloys containing a high percentage of nickel, such as the Nimonic and Inconel groups, continued to retain an outstanding position in aircraft gas turbines and jet engines. The plating industry received more nickel in 1954 than in 1953, but supplies were still inadequate.

Production of cupro-nickel alloys containing 10 to 30 per cent. nickel increased in 1954, and although nickel-chromium alloy castings declined in tonnage during the year, the average nickel content increased, so the amount of primary nickel absorbed was little changed. The principal use for these alloy castings continues to be in the heat-treating furnace field and for resistance to corrosion. An increased use of corrosion-resisting nickel cast iron and abrasion-resisting nickel-chromium cast iron was developed during the year by the mining industry, and extended use of them is being made in the paint and cement industries. Other increased fields of application have been nickel for catalysts, nickel compounds in the ceramic and electronic industries, and nickel for batteries. According to Dr. J. F. Thompson, the chairman of the International Nickel Company of Canada, these uses will be further developed in 1955. " It is expected " he said recently " that after satisfying defence requirements and deliveries to Government stockpiles under present schedules, more nickel will be available to free-world industry for civilian applications in 1955, than was the case in 1954."

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A Weekly Survey note in our issue of December 31 referred to Crompton Parkinson, Limited, and the successful year reported by their chairman, Mr. Albert Parkinson, M.B.E. The note also gave information on the production of electric motors. We wish to make it clear that the second paragraph, in which this information was given, referred to the British industry as a whole, not specifically to Crompton Parkinson, whose products include—as is widely known—switchgear, transformers, lamps, instruments, batteries and cable, as well as motors, generators and alternators.

THE HISTORY OF ROAD VEHICLES

NEW SECTION AT THE BIRMINGHAM MUSEUM OF SCIENCE AND INDUSTRY

The Birmingham Museum of Science and Industry, Newhall Street, Birmingham, 3, was opened in May, 1951, the first items to be displayed being a part of the City's collection of firearms. The Museum authorities had taken over a large block of industrial buildings, which had to be adapted for Museum purposes, and it was announced at the time of the official opening that further permanent displays would be opened as soon as the necessary work of adaptation was completed. Numerous parts of the buildings have been repaired and redecorated, and at intervals new sections of the Museum have been opened to the public; these sections include a room devoted to the activities of Boulton and Watt, an exhibition of modern scientific and electrical equipment, and a large engineering hall. All these have been noted in ENGINEERING at the appropriate times.

The latest addition to the Museum is the Transport Section, which was officially opened by the Lord Mayor of Birmingham, Alderman J. R. Balmer, J.P., on December 8. The exhibits, which are at present all road vehicles, are housed on the ground floor of a large modern steel-framed building, which is well lighted naturally from both sides. Most of the exhibits are mechanically propelled, but there is a good collection of bicycles and other manually-propelled vehicles. Of the mechanically-propelled vehicles, motor cars of various ages form the largest group, but motor cycles are also well represented. The exhibits are from various sources, some are on loan from private individuals or firms, while others form part of the Museum's permanent collection. Changes will be made from time to time, as loan exhibits are returned to their owners, as new additions to the permanent collection are made, and as items for which there is insufficient display room are brought in to replace some of those at present on show.

The motor-cycle exhibits are on the left as a visitor enters the Transport Section, with a bicycle display beyond them. Motor cars occupy the whole of the right-hand side of the room, and the centre contains car engines and a 1½-litre supercharged B.R.M. racing car.

MOTOR CYCLES

In the motor-cycle group there are some well-known makes, such as the Douglas flat-twin, which is represented by two machines, one of 1917 and one of 1923; a Rudge-Whitworth of 1923, popularly known as the " Rudge-Multi "; and a 3½-h.p. Triumph of 1912. It is fitting that the Midlands, which are the home of such a large part of the motor-cycle trade, should be well represented; both the Triumph and the Rudge came from Coventry, and there is also a Wearwell Stevens machine of 1904, which was made in Wolverhampton. This is a lightweight machine, with a single-cylinder 350-c.c. engine, and has neither clutch nor gearbox. The Triumph is of 499 c.c. capacity, and has the two-speed rear hub with V-belt drive which is a well-remembered feature of these machines. Both the Douglas machines are very similar, differing only in that one is fitted with a kick-start in addition to the two-speed gearbox. Both are in excellent condition, and are good examples of a highly successful model of its time. The Rudge, again, is a machine which was very popular, and has the well-known variable-speed cone pulley final drive and multi-plate metal-to-metal clutch.

Perhaps the most outstanding item in the motor-cycle group, however, is the Belgian Fabrique Nationale 448-c.c. machine of 1907. This has a four-cylinder engine, the cylinders being in line and cast separately, automatic inlet valves, and shaft and bevel-gear final drive. In addition to these features, which are unusual for the date of manufacture, the F.N. motor cycle has an internal-expanding shoe-type rear brake, in contrast to the rim-type brakes which were often fitted to other machines at a much later date. It has, however, no front brake, clutch or gearbox. There are other old machines in the motor-cycle group, and, for contrast three modern machines, which have been lent by the British Cycle and Motor Cycle Manufacturers' and Traders' Union, Limited, and will be changed from time to time.

BICYCLES AND TRICYCLES

Near to the motor-cycle group and separated from it by two motor cars there is an exhibition of bicycles and tricycles several of which are from the Tickenhill Collection formed by Mr. J. F. Parker, and formerly kept by him at his house at Tickenhill, Bewdley, Worcestershire. In this corner of the Transport Section it is possible to trace the development of the bicycle from the early " boneshaker " of 1868, on which the rider sat astride a crude saddle and pushed with his feet on the ground, through the 56-in. wheel " penny farthing " and the " safety " cycle to the machines of the present day. Again, the Midlands are well represented, the exhibits including a Humber " safety " cycle of 1882-83, and a Coventry " semi-sociable " of 1880. This latter machine is of curious design by modern standards, having three wheels, one large one for propulsion, and two small ones, arranged in tandem and alongside the large one, for steering. The rider, who was seated between the large and the two small wheels, propelled the machine by cranks and a chain driving the large wheel, and steered it by a handle and link-rods connected to the small wheels. A Dursley-Pedersen bicycle of 1902, with a " hammock " type frame, shows one of the many unusual designs to be found in cycle history and as a complete contrast there is a native-made African cycle, constructed entirely of wood, and obviously copied, with great pains and considerable skill, from an imported steel machine.

The Transport Section of the Birmingham Museum of Science and Industry is displaying a representative collection of motor cycles, bicycles and tricycles, and motor cars, which occupy the whole of one side of the building.

MOTOR CARS

In the motor-car group the Midlands are also well represented, though the earlier models displayed naturally include some vehicles of foreign origin. Since so many of the earlier cars were modelled on the horse-drawn dog-car, a vehicle of this type, dating from the latter part of the Nineteenth Century, has been included in the motor-car group. The mechanically-propelled vehicles immediately adjacent to it show how faithfully the early motor-car builders followed the example of the older vehicle. There is, for example, an Argyll " Voiturette " of 1900, which has a de Dion Bouton single-cylinder engine of 267 c.c., developing 3 brake horse-power at 1,500 to 2,000 r.p.m., and a Birmingham-made Wolseley, also single-cylindered, but of 1,375 c.c. and having a brake horse-power of 4½ at 750 r.p.m.

Another celebrated Midland product, the Rolls-Royce, is represented by a two-cylinder 10-h.p. car of 1905, which is of 1,800 c.c. capacity, and is of particular interest as showing how marked had been the progress in motor-car design in the first few years of the present century. The car has a three-speed gearbox, cone clutch with leather lining and bevel gear final drive. It forms a marked contrast with the 1900 Benz, which is placed near to it, and has a 3½-h.p. single-cylinder horizontal engine and belt transmission.

An Austin town car of 1911 also shows a considerable step forward in design, particularly as regards the body. The passengers are seated comfortably in an enclosed saloon, with large glass windows, and even the driver is afforded some protection, as the roof extends to the front of the car, there is a glass windscreen, and side curtains which can be rolled down. The engine develops 25 brake horse-power at 900 r.p.m. In the same category, but later, is a Daimler saloon of 1924, with the well-known Knight sleeve-valve engine, rated at 20·06 h.p. on the old R.A.C. rating. This car has electric lights and four speeds, and is totally enclosed. It is a good example of post 1914-18 war design, and shows a further step towards the saloon car of today.

In the smaller " owner-driver " class, two cars, a Singer of 1919 and a Bean of 1927, are particularly good examples. Both are of the coupé type popular at the time, and both have heavy coach-built bodies. The Singer is the smaller of the two, with a four-cylinder engine of 1,097 c.c., the cylinders being cast in pairs, while the Bean, which represents a make of car now extinct, has a four-cylinder monobloc engine of 2,385 c.c.

In the Transport Section motor-car group it is possible to trace the whole development of the motor car from the powered " dog-cart " to the present day model, and from the single-cylinder horizontal " gas-engine " power unit to the modern high-speed, high-power engine. In following the design developments through in rough chronological order, some features will be observed which might prove surprising to a visitor not closely conversant with motor-car history. For example, an overhead drive worm

and wheel rear axle can be seen on a Rover chassis of 1910, which also has coil-spring shock absorbers on the rear axle. Similarly, the curved windows which are fitted to some cars to-day, to improve vision at the roof pillars, can be seen on a 1911 Austin.

Many phases of car development can be studied, and the evolution of individual items of equipment such as wheels, springing, accessories and controls is indicated clearly by the numerous exhibits. The origin of the spare wheel, for example, is seen in the Stepney wheel, which was a separate steel rim carrying a tyre, and was clamped on to the side of the road wheel in the event of a puncture.

Two modern cars are included, and they provide an interesting contrast with the vehicles alongside which they are placed. A 1952 Jaguar XK 120 of 3½ litres capacity is contrasted with a 1912 four-cylinder Benz of 22 litres; both cars develop the same brake horse-power, and illustrate the advance in engine speeds and design over the years. Contrasted with the 1911 Austin town car is a modern Austin A90 " convertible," which has a special claim to notice. This is the car which was taken to the Indianapolis speedway in America in 1948 and established numerous speed records for a production car, running at an average speed of 70·54 m.p.h. for seven days and nights.

The exhibits are described briefly by a notice placed prominently near to each one, and full specifications and photographs are available for purchase by visitors to the Museum.

* * *

AREA BOARDS OF BRITISH TRANSPORT COMMISSION

The British Transport Commission have now announced the names of the chairmen and members of the Area Boards of the Commission.

The chairman of the SCOTTISH AREA BOARD is Sir Ian Bolton, Bt., O.B.E., a member of the Commission, and the other members include Lord Bilsland, M.C., chairman of Bilsland Bros. Ltd., and a director of John Brown & Co. Ltd., and other companies; Mr. J. C. Denholm, C.B.E., partner in J. & J. Denholm Ltd., Shipowners, Glasgow; and Mr. W. G. N. Walker, chairman of Jute Industries Ltd.

Presiding as chairman over the NORTH-EASTERN AREA BOARD is Mr. T. H. Summerson, J.P., chairman of Thomas Summerson & Sons Ltd., and other industrial undertakings. Among the other members are Dr. J. W. Armit, M.A., member of the Tees Conservancy Commission and formerly of Imperial Chemical Industries Ltd., Wilton, N. Yorks; and Mr. P. D. Priestman, managing director of Priestman Bros. Ltd.

The EASTERN AREA BOARD has as its chairman Sir Reginald Wilson, a member of the Commission. Also serving on this Board is Mr. A. F. Pegler, vice-chairman, Northern Rubber Co. Ltd.

The chairman of the SOUTHERN AREA BOARD is Sir Philip Warter, chairman, Associated British Picture Corporation Ltd. The other members include Mr. H. L. R. Matthews, C.B.E., a consultant chartered surveyor, Mr. K. Preston, chairman and managing director, J. Stone & Co. (Holdings) Ltd., and Mr. A. B. B. Valentine, a member of the Commission.

At the head of the WESTERN AREA BOARD is Sir Herbert Merrett, chairman of Cory Bros. & Co. Ltd. and Powell Duffryn Ltd. Among the other members are Mr. Arthur Chamberlain, M.C., T.D., director, Tube Investments Ltd.; Sir John Carew Pole, D.S.O., T.D., chairman, Cornwall County Council; Mr. John Ryan, C.B.E., M.C., a member of the Commission; and Captain Hugh Vivian, a former chairman of Beyer Peacock & Co. Ltd. and a director of Associated Electrical Industries Ltd. and other companies.

Lord Rusholme, a member of the Commission, is to be chairman of the LONDON MIDLAND AREA BOARD on which Mr. R. F. Summers, chairman of John Summers & Sons Ltd. and a director of the United Steel Companies Ltd., is also sitting.

The Boards, which were set up on January 1, will begin to exercise the functions delegated to them by Article 5 of the British Transport Commission (Organisation) Scheme Order, 1954, on February 1.

ENGINEERING CENTENARIES IN 1955

Bessemer's Open-Hearth Process

Among the centenaries which occur in 1955 are two of outstanding interest to mining engineers and metallurgists, for it was on October 17, 1855, a century ago that Bessemer secured his patent for his revolutionary method of producing a superior malleable iron, afterwards known as " mild steel," while 400 years ago, on November 21, 1555, occurred the death of Georgius Agricola whom Hadfield called " the Bessemer of his day " and whose book *De re Metallica* was for nearly 300 years the text-book and guide to metallurgists and miners alike.

Of Bessemer's invention the American Engineer Abraham Hewitt (1822-1903) said that it takes rank " with those great events which have changed the face of Society since the Middle Ages. The invention of printing, the construction of the magnetic compass, the discovery of America and the introduction of the steam engine are the only capital events in world history which belong to the same category as the Bessemer process." Sir Henry Bessemer was born in 1813 and died in 1898 and so lived in an era when Britain was the workshop of the world; Sir Henry's autobiography was published by ENGINEERING in 1905.

Agricola on the other hand was a child of the Rennaissance, a Latinist, a humanist, a teacher and a physician and it was while practising in the mining districts of Bohemia and Saxony that he probed into all the problems and processes of the mining and refining of metals and wrote his great work. The manuscript was completed by 1553 but the book was not published until some months after Agricola's death at Chemnitz at the age of 61. Written in Latin, it was soon translated into German and Italian, but the English translation published in 1912 was the work of two Americans, President Herbert Hoover and the late Mrs. Hoover.

In the list of engineers born 200 years ago the first place must go to the distinguished French civil engineer Baron de Prony (1755-1839) whose name is widely known for his development of the absorption brake. He is a representative of the group of academically-trained engineers who, in the days of our Smeaton and Telford, belonged to the Corps des Ponts et Chaussées and were responsible for the roads, bridges, canals, harbours, etc., of France. A tribute to him was published in our columns on July 27, 1939. In marked contrast with the career of Prony was that of the American millwright and inventor Oliver Evans (1755-1819). Apprenticed to a wheelwright, he made many improvements in flour milling and, like Trevithick, was a pioneer of the high-pressure steam engine.

For more than a century and a half the name of Donkin has been familiar to engineers and, five years ago, the late Sydney Bryan Donkin (1871-1952) read a paper to the Newcomen Society on his forbear entitled " Bryan Donkin, M.I.C.E., F.R.S., 1768-1855." This, the first of several Bryan Donkins, began his engineering career at Hall's of Dartford, and it was John Hall who enlisted his assistance in developing the paper-making machine of the ill-requited Frenchman, Louis Robert. An active and versatile man, Bryan Donkin played many parts but it is considered that his greatest achievement was the construction of the first practical paper-making machine. Donkin died on February 27, 1855, at the age of 87. Only four days before Donkin's death, Germany had lost her famous mathematician, astronomer and physicist, Karl Freidrich Gauss (1777-1855) who began life as the son of a bricklayer but became one of Germany's leading scientists and for 50 years was a professor at Göttingen. Thousands who have never heard of him, to-day know something of " de-gaussing." He was the first German to receive the Copley Medal of the Royal Society.

To the same class of workers as Gauss, known alike as teachers and investigators, belong the two well-known Scottish physicists Professor Archibald Barr (1855-1931) who from 1889 to 1913 held the Chair of Engineering in the University of Glasgow and who, with his Leeds colleague Professor Stroud, developed the Barr and Stroud rangefinder, and Sir Alfred Ewing (1855-1935) whose career took him from Dundee to Edinburgh and Tokyo, then back to Dundee and Cambridge, and after several years as Director of Naval Education again to Edinburgh where, from 1916 to 1929, he was Principal and vice-chancellor. He was once termed the Patron Saint of Cambridge Engineering.

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Letters to the Editor

TOYS

SIR, Though your Weekly Survey note on " Toys " (December 24, page 811) is interesting, it does not really cover the correct position with regard to my Company. I myself have been manufacturing toys for 57 years—I am happy to say always successfully from the pocket point of view—and we have grown up during that time facing the fiercest competition from German, Japanese and other overseas companies; for a large portion of that period with no protection whatever, and latterly with the very minimum of tariff protection.

We have accumulated a large export trade, apart from production in our own overseas factories; this is still increasing and we have every confidence in our future ability to compete on fair terms. Our manufacturing activities have spread into the Dominions in a large way and this is still going on. The secret of this is that we always have had to face competition round the world and we have done it by installing the most modern plant and methods.

Your note does less than justice to the Lines Bros. Group. It states that toy manufacturers gained experience in mass-production methods during the war period, but we were already 95 per cent. manufacturers of steel articles and we had an extremely large equipment of all the plant necessary, including 500 power presses up to 300 tons, to produce metal articles.

We had a very large tool-room—one of the largest, if not the largest, in London, also equipped with the best tool-room machinery, English and American, which enabled us to make the tools required for munition production, only using outside tool producers in a small way. The boot was on the other foot with regard to mass production. We were able to show many manufacturers of metal goods how to make munitions economically.

Our works were already highly " conveyerised " and we made a good deal of our own special machinery and plant. As far as the cost of production is concerned—to put it mildly, we wiped the eye of anybody else producing anything similar. We designed the Mk. III Sten gun at a time when arms were desperately needed and started producing it from the word " go " in two months, and made over one million (whereas other celebrated engineering concerns spent more than a year on getting into production). Moreover, we turned them out at the rate of 4,000 or 5,000 a day complete together with 30,000 to 40,000 magazines a day also. We made mines, aeroplane parts, complete gliders, shells, fuses and other items.

We might add that at Merton we have over four miles of north-light roof factory and in other parts of the country as much again. We have over 8,000 employees and over 1,500,000 sq. ft. of floor space. Perhaps we have not publicised this sufficiently; in fact, we have been so busy that we have not had time to, but perhaps some day we will get down to it.

Yours truly,
WALTER LINES.

Lines Bros., Ltd.,
Tri-ang Works,
London, S.W.19.
December 29, 1954.

Obituary

LIEUT.-COLONEL H. P. T. LEFROY, D.S.O., M.C.

We regret to record the death of Lieut.-Colonel H. P. T. Lefroy, which occurred at Carrigglas Manor, County Longford, Ireland, on Sunday, December 26, at the age of 74.

Hugh Percival Thomson Lefroy, who was descended from a Huguenot family, was educated at Cheltenham College and at the Royal Military Academy, Woolwich. He obtained a Commission in the Corps of Royal Engineers in 1899; and served in the South African War, where he was engaged on railway work. After further military service in this country and at Gibraltar, he turned his attention to radio communication, then in the early stages of its development; and in 1909 was appointed head of an experimental section for developing Army field and aircraft wireless. For the next five years he carried out much useful research in this subject and good use was made of his knowledge during the 1914-18 war.

From 1920 to 1922 he held an appointment at the Signals Experimental Establishment, Woolwich, and after his retirement from the Army with the rank of lieutenant-colonel in the latter year, had charge of radio research work at the Air Ministry until 1927. During this period, he was also representative of the Ministry on the Radio Research Board and on the Committee of the Radio Section of the Institution of Electrical Engineers.

For his services during the 1914-18 war, in the course of which he served in France, Egypt, Salonika, Mesopotamia and Persia, he was awarded both the Distinguished Service Order and the Military Cross. He was also Chevalier of the Legion of Honour. He was elected an Associate Member of the Institution of Electrical Engineers in 1910.

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DR. T. W. CHALMERS

It was with much regret that we recorded in last week's issue the death, on December 22, of Dr. T. W. Chalmers, consultant editor of our contemporary, *The Engineer*, with which he had been associated for 45 years. He had been in poor health for a considerable period and for that reason had not been often seen at engineering and scientific gatherings for some time past, but the news of his death was not generally expected, for he was still quietly active until comparatively recently.

Thomas Wightman Chalmers was a native of Glasgow, where he was born on August 23, 1884, and received his general education at Hillhead High School and Glasgow High School. In 1901, he began an engineering apprenticeship in the Hyde Park Locomotive Works of Neilson and Company, later absorbed into the North British Locomotive Company, where he served both in the shops and in the drawing office. Between 1904 and 1908, he took the B.Sc. (Engineering) course in Glasgow University, graduating in the latter year with distinction in engineering subjects and in natural philosophy, and gaining a Walker Prize. He was also awarded a James Watt post-graduate scholarship, which he applied to an investigation of the specific heat of superheated steam, designing and constructing his own apparatus for the purpose.

On the conclusion of this work, he joined the staff of *The Engineer* as an assistant editor under the late Mr. Loughnan Pendred, eventually becoming chief assistant editor. During the first World War he edited the *Ministry of Munitions Journal* from 1916 to 1918. When, in 1946, Mr. Pendred retired and was succeeded by his son, Mr. B. W. Pendred, Chalmers was appointed consultant editor. His health, even then, was beginning to fail, but he continued to pursue the philosophical inquiries which had always been among his chief interests, typical of which was the series of *Historic Researches* which was published in book form in 1949. It was the last of several volumes in which he embodied the material of articles previously published serially, earlier works dealing with *The Production and Treatment of Vegetable Oils*, *Paper Making and Its Machinery*, and *The Gyroscopic Compass*. The theory of the gyroscope interested him greatly and it was for work on this subject, we understand, that he was awarded his D.Sc. degree by the University of Glasgow. He was a clear thinker and a lucid writer, knowledgeable on a wide range of topics, and a mathematician of considerable ability. He was a member of the Institution of Mechanical Engineers, to which he was elected as an associate member in 1910, being transferred to the grade of member 20 years later; and, though he seldom took part in discussions, his views—sometimes expressed with decided pungency, seasoned with a characteristic Scottish humour—were often sought by his numerous friends, to whom the fruits of his wide reading and extensive scientific knowledge were always freely available.

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We regret also to record the deaths of:

MR. WILLIE MILLS, on December 25, at the age of 66. Mr. Mills was a director, former secretary and oldest employee of Brook Motors Ltd., Empress Works, Huddersfield. He retired from the position of secretary in February, 1954, owing to failing health. Mr. Mills had been made a director in 1918 and remained on the board up till the time of his death.

MR. RALPH SAMUEL HARBORNE, M.Sc.(Bristol), F.R.I.C., M.I.Chem.E., on December 29, at the age of 57. Mr. Harborne was one of the founders of Base Metal Products Ltd., suppliers of lead oxide for accumulators, Wembley, Middlesex, established in 1932, and latterly had been chairman and joint managing director of the company.

ENGINEER REAR-ADMIRAL WILLIAM JOHN DIXON, on December 28, at the age of 79. He served as chief engineer of Simonstown Dockyard, South Africa, from 1923 until 1926, and, from 1926 until his retirement in 1929, as Admiralty Overseer in the Sheffield and Leeds districts.

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PERSONAL

SIR CHARLES BARTLETT, F.R.S.A., M.I.Mech.E., M.I.P.E., managing director of Vauxhall Motors Ltd., Luton, Bedfordshire, for 23 years and chairman since June, 1953, retired from the company on December 31, 1954. He is also relinguishing his seat on the board.

MR. J. S. JEFFREY resigned his position as joint managing director and retired from the board of the Woodall-Duckham Construction Co. Ltd., Woodall-Duckham House, 63-77, Brompton-road, London, S.W.3, on December 31, 1954. He will retain, however, his directorship of the parent company, Woodall-Duckham Ltd., and other directorships which he holds on behalf of the Woodall-Duckham Group. Mr. Jeffrey joined the staff of the company in 1912. MR. J. SIMPSON has been appointed joint managing director of the Woodall-Duckham Construction Co. Ltd., as from January 1.

MR. G. R. TYLER has retired from the position of manager of the Maritime Division of Marconi's Wireless Telegraph Co. Ltd., Chelmsford, Essex, but is continuing his work for the company as their representative in West Africa. Mr. Tyler's successor as manager, Maritime Division, is MR. B. G. H ROWLEY, M.A. (Oxon.), A.M.I.E.E.

MR. F. S. WHALLEY, M.C., M.I.Mech.E., M.I.Loco.E., is relinguishing his directorships of Vulcan Foundry Ltd., and of Robert Stephenson and Hawthorns Ltd.

MR. FREDERICK WALKER, O.B.E., M.I.Mech.E., chief engineer of the Dunlop Rubber Co. Ltd., at Fort Dunlop, retired on December 31, 1954, after 40 years of service with the company.

MR. J. MCMILLAN, principal surveyor to Lloyd's Register of Shipping at Hull, retired on December 31, 1954, having reached pensionable age. His successor is MR. A. W. B. EDWARDS, hitherto a senior ship and engineer surveyor at Hull.

MR. F. NIXON, B.Sc.(Manc.), M.I.Mech.E., F.R.Ae.S., succeeded MR. E. J. CANTRILL as chief quality engineer, Aero-Division, Rolls-Royce Ltd., Derby, on Mr. Cantrill's retirement on December 31.

MR. F. R. JOLLEY, M.Sc., A.M.I.C.E., and MR. J. R. ROWLANDS, M.I.Mech.E., have been appointed joint managing directors of Simon Handling Engineers Ltd., Cheadle Heath, Stockport, Cheshire, with effect from January 1. MR. I. HEY, M.Sc.(Tech.), M.I.Mech.E., remains chairman of the company.

MR. T. E. LAING, who has been works manager and, more recently, general manager of the joint factories at Barry, Glamorgan, of British Resin Products Ltd., and British Geon Ltd., since they were built in 1947, has been elected a director of British Resin Products Ltd.

DR. W. D. SCOTT, who recently relinquished his appointment with Monsanto Chemicals Ltd., has joined British Tyre and Rubber Co. Ltd., Herga House, Vincent-square, London, S.W.1, as personal assistant to the managing director, MR. P. W. HOWARD.

MR. C. C. BIRCH has joined Guest Keen and Nettlefolds (Midlands) Ltd., and has been appointed general works manager of the screw division. He took up his appointment on January 3.

MR. HAMISH LITHGOW, general manager, Wallsend Shipyard, Swan, Hunter, and Wigham Richardson Ltd., is retiring after 49 years' service.

MR. H. C. THOMAS, M.M., director and secretary, Northern Aluminium Co. Ltd., Banbury, Oxfordshire, has retired. He joined the staff of the firm at the London office on January 1, 1925.

MR. ARCHIBALD ALEXANDER, C.A., secretary and a director of Scotts' Shipbuilding and Engineering Co., Ltd., Greenock, has retired.

MR. HILTON HUTCHINSON, manager of the Howdon-on-Tyne repair yard of the Tyne Improvement Commission, is retiring after upwards of 40 years of service at the yard.

MR. G. WATSON-WILLIAMS has accepted an appointment from the United Nations Technical Assistance Administration to serve as an industrial economist to the Government of Indonesia, at Djarkata. The appointment, which is for one year, has been made at the request of the Indonesian Government.

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COMMERCIAL

HEAD, WRIGHTSON & CO., LTD., Thornaby-on-Tees, have acquired the whole share capital of F. P. CAIRD & CO. LTD., 19, Waterloo-street, Glasgow. The name of the company is being changed to HEAD WRIGHTSON (SCOTLAND) LTD. The new directors are SIR JOHN WRIGHTSON, Bt., MR. PETER WRIGHTSON and MR. J. W. WARDELL. MR. J. T. YOUNG will be the official responsible for the operation of the Glasgow office.

As a consequence of the recent transfer of the POWELL DUFFRYN GROUP shareholding in the VACUUM OIL CO. LTD., to SOCONY-VACUUM OIL CO. INC., of New York, the five directors nominated by the Powell Duffryn Group, namely, SIR HERBERT MERRETT, SIR HENRY WILSON SMITH, K.C.B., K.B.E., MR. W. M. CODRINGTON, MR. M. B. REID, M.B.E., M.C., J.P., and MR. H. V. VALE, resigned on December 21, 1954, from the board of the Vacuum Oil Co. The company is now a wholly-owned subsidiary concern of Socony-Vacuum. On the invitation of that company, SIR HENRY WILSON SMITH and MR. M. B. REID have been re-elected to the board of the Vacuum Oil Co. Ltd., which now consists of MR. J. C. GRIDLEY, C.B.E. (chairman), MR. H. W. ROCKE (managing director) and MR. C. LAWRIE, MR. J. B. MIDDLETON, MR. M. B. REID, SIR HENRY WILSON SMITH, and MR. J. S. VESEY BROWN.

Representation for the full range of the compressed-air products of the CONSOLIDATED PNEUMATIC TOOL CO. LTD., 232, Dawes-road, London, S.W.6, in the British West African territories, has been arranged with the UNITED AFRICA CO. LTD., Unilever House, London, E.C.4, with offices in the Gold Coast at Accra, Takoradi and Kumasi, and offices in Nigeria at Kaduna, Lagos and Enugu. MR. P. J. DARNELL has been appointed resident technical representative.

DAVIES & METCALFE LTD., Injector Works, Romiley, near Manchester, have acquired the sole rights to manufacture and sell, in the United Kingdom and the Commonwealth, a new and improved design of air-braking equipment for railway locomotives. The equipment has been developed by the OERLIKON ENGINEERING COMPANY, Zürich, and prolonged tests have been carried out by a number of European railways.

An agreement has recently been signed between NORTH EASTERN TRADING ESTATES LTD. and the RANSOME AND MARLES BEARING CO. LTD., Newark-on-Trent, for an immediate extension to their new factory, opened in 1953, at Annfield Plain, Co.

Durham. The inauguration of the factory was described in ENGINEERING, vol. 176, page 467 (1953).

To safeguard the body-supply position of their Automobile Division, for both Aston Martin and Lagonda cars, the DAVID BROWN COMPANIES have acquired TICKFORD LTD., coach builders, Newport Pagnell, Buckinghamshire. MR. I. I. BOSWELL is to remain as managing director. It is planned to develop production facilities at Newport Pagnell. The London branch of Tickford Ltd. is not included in the transfer and will continue its business as at present.

WICKMAN LTD., and WILD-BARFIELD ELECTRIC FURNACES LTD., announce that agreement has been reached between the two companies whereby the induction-heating business of Wickman Ltd. has been acquired by Wild-Barfield as from January 1. The manufacture of the plant will continue at the existing address at Oxgate-lane, Cricklewood, London, N.W.2, for the present, after which it will be transferred to the Wild-Barfield Works at Watford. MR. F. L. GLADWIN of Wickman Ltd. has been appointed sales manager of the Wild-Barfield induction-heating department.

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HONOURS LIST

Many engineers, industrialists and scientists are among those whose names are contained in the New Year Honours List, published on January 1. Included among them are those mentioned below.

Barons

Edgar Douglas Adrian, O.M., President of the Royal Society, President of the British Association, and Master of Trinity College, Cambridge; and Sir William Fraser, C.B.E., chairman of the Anglo-Iranian Oil Co., Ltd.

Privy Councillor

Evelyn Nigel Chetwode Birch, O.B.E., M.P., Minister of Works since October, 1954.

Knights Bachelor

Ivor R. Cox, D.S.O., for services as managing director, Metropolitan-Vickers Electrical Co., Ltd.; Robert A. Maclean, for services to industry in Scotland; Philip E. Millborn, C.M.G., honorary adviser on shipping in port to the Minister of Transport and Civil Aviation; Keith A. H. Murray, chairman, University Grants Committee; Wilfred J. Neden, C.B., C.B.E., Chief Industrial Commissioner, Ministry of Labour and National Service; Sydney G. Russell, C.B.E., M.C., designer and artist; Leonard Sinclair, chairman and managing director, Esso Petroleum Co., Ltd.; Rear-Admiral Matthew S. Slattery, C.B. (ret'd.), chairman and managing director, Short Brothers and Harland, Ltd., Belfast; Henry Spurrier, managing director, Leyland Motors Ltd.; and Oliver G. Sutton, C.B.E., director of the Meteorological Office, Air Ministry.

Order of the Bath

G.C.B. Sir John P. R. Maud, K.C.B., C.B.E., Permanent Secretary, Ministry of Fuel and Power.

K.C.B. Vice-Admiral (E) Frank T. Mason, C.B.

C.B. Rear-Admiral (E) John G. C. Given, C.B.E.; George R. D. Hogg, C.B.E., Under-Secretary, Department of Scientific and Industrial Research; William R. McGaw, director general of aircraft production, Ministry of Supply; Rear-Admiral (E) Philip C. Taylor; Major-General Leslie N. Tyler, O.B.E., R.E.M.E.

Order of Saint Michael and Saint George

C.M.G. Theodore L. Bowring, O.B.E., director of public works, Hong Kong; John F. R. Hill, member for communications, works and development planning, Tanganyika; Edward W. Senior, commercial director, British Iron and Steel Federation.

Queen's Commendation for Valuable Service in the Air

Mrs. Anne Burns, principal scientific officer, Royal Aircraft Establishment, Ministry of Supply. (Church Crookham, Hampshire.)

Order of the British Empire

K.B.E. Sir (Arthur) Wilfrid Garrett, chairman, Industrial Injuries Advisory Council; Owen H. Wansbrough-Jones, C.B., O.B.E., chief scientist, Ministry of Supply; and Eric A. Seal, C.B., deputy secretary, Ministry of Works.

C.B.E. Risdon A. Beazley, chairman and managing director, Risdon Beazley, Ltd., Southampton; John Beaumont, O.B.E., A.F.C., Commandant, Technical Training College, Indian Air Force, Jalahalli, India; David Blee, chief of commercial services, British Transport Commission; Charles S. Bryant, lately director of materials, and explosives research and development, Ministry of Supply; Brigadier (temporary) Geoffrey E. Butler, R.E.M.E.; Herbert A. Campbell, O.B.E., for services to the rubber industry in Malaya; Brigadier (temporary) Laurence F. de V. Carey, late Corps of Royal Engineers; Lewis Chapman, managing director, William Jessop and Sons, Ltd., Sheffield; John C. Clark, M.C., Director of the Rural Industries Bureau; Isaac W. Cumberbatch, O.B.E., chairman, West Midlands Division, National Coal Board; Colonel (temporary) Eric P. Dickson, Corps of Royal Engineers; Colonel (temporary) Henry Grattan, Corps of Royal Engineers; Frederick W. Halliwell, President of the Gauge and Tool Makers' Association; Harold W. Hobbs, director of ordnance factories, Nottingham, Ministry of Supply; Frederick J. C. Honey, secretary, British Employers' Confederation; Horace E. Jackson, lately President, British Non-Ferrous Metals Federation; Miss Dorothy Johnson, deputy chief inspector of factories, Ministry of Labour and National Service; William E. C. Lazenby, lately member of the Industrial Court; Neil C. Macnamara, chairman and managing director, Trollope and Colls, Ltd., London; Brigadier Kenneth Mackay, D.S.O., O.B.E., late Corps of Royal Engineers; Cecil T. Melling, chairman, Eastern Electricity Board; George Ormiston, superintendent engineer, New Zealand Shipping Co. Ltd., and Federal Steam Navigation Co., Ltd.; Alfred H. Parker, Assistant Director of Dockyards, Admiralty; Victor A. Patterson, J.P., deputy chairman and managing director, J. and E. Hall, Ltd., Dartford; David A. Shirlaw, Director of Administration and Accounts, Atomic Energy Authority; Professor Charles H. Smith, Department of Instrument Technology, Royal Military College of Science; Group Captain John B. Veal, A.F.C., Aviation Safety and Licensing, Ministry of Transport and Civil Aviation; Alfred Watson, chief mechanical and electrical engineer, Air Ministry; George S. Wells, M.C., deputy chief engineer, Ministry of Housing and Local Government; and Major Francis R. B. Whitehouse, M.B.E., chairman and managing director, Chad Valley Co., Ltd., Birmingham.

O.B.E. Harold J. Atkinson, area general manager, North Eastern Division, National Coal Board; George W. Bain, chief engineer, S.S. "Mauretania," Cunard Steamship Co., Ltd.; Lieutenant-Colonel Herbert H. Broadbent, T.D., R.E.M.E., Territorial Army; Lieutenant-Colonel the Right Honourable Edward Southwell, Baron de Clifford, T.D., R.E.M.E.; Robert Connor, director and general Manager, Measurement, Ltd., Oldham, Lancashire; Commander (E) Frederick J. S. Corney, R. N. (retd.); George Daly, M.B.E., staff controller, Engineering Department, General Post Office; Herbert Duckworth, superintending electrical engineer, Admiralty Engineering Laboratory, West Drayton; William J. Dyer, resident engineer, Hanningfield Reservoir, Essex; G. D. Elliott, works manager (iron), Appleby-Frodingham Branch, United Steel Companies Ltd., Sheffield; Wynn H. Evans, principal scientific officer, Safety in Mines Research Establishment, Ministry of Fuel and Power; William J. Felton, secretary, Institution of Mining and Metallurgy; Alfred E. Gollop, assistant director of storage, Ministry of Supply; Frederic A. Gould, lately senior principal scientific officer, National Physical Laboratory, Department of Scientific and Industrial Research; A. S. Hartshorn, recently scientific attaché, H.M. Embassy, Paris (now principal scientific officer, Royal Aircraft Establishment, Farnborough); Gerald A. Hill, director, Higgs and Hill, Ltd., Crown Works, London; Arthur T. Horton, principal scientific officer, Ministry of Defence; Professor Leslie Howarth, Department of Applied Mathematics, University of Bristol; Ronald C. Kelt, M.B.E., engineer-in-chief and inspector-general of ports and navigation, Basra; Herbert J. Jones, technical consultant, Hemingway and Co., Ltd.; Herman R. Lindars, for services in the field of fuel efficiency; Captain John H. J. Martin, works manager, Elswick and Scotswood Works, Vickers-Armstrongs, Ltd.; Alan S. Milward, deputy chief engineer, office of Crown Agents for Overseas Governments; James A. F. Morrison, M.M., city quantity surveyor, Dundee; Peter Philip, area manager, Dundee, North of Scotland, Hydro-Electric Board; Donald H. Reed, superintending examiner patent Office, Board of Trade; Geoffrey H. G. Richards, Director, Mechanical Transport Department, Sudan Government; Harold Ringshaw, chief engineer, R.F.A. Service; Eric L. Ripley, principal scientific officer, Structures Department, Ministry of Supply; Vernon W. M. Roberts, Electronics Department, British Thomson-Houston Co., Ltd., Rugby; Lieutenant-Colonel Roy C. Salmon, R.E.M.E.; Jack Shackleton, engineering superintendent of design, Atomic Energy Authority; John L. Sharratt, borough engineer and surveyor, Shoreditch; William J. Shea, M.B.E., principal, Ministry of Transport and Civil Aviation; Robert Spence, director and general manager, John Hastie and Co., Ltd. Greenock; Donald Todd, Deputy Director of Armament Supply, Admiralty; George A. Vowles, divisional controller, Yorkshire Division, British Electricity Authority; Professor Frederick V. Warnock, Head of the Department of Mechanical Engineering, Belfast Municipal College of Technology; Norman H. A. Warren, senior principal scientific officer, Admiralty Gunnery Establishment, Portland; David Watson, Principal, Ministry of Works; and William H. Yoxall, G.M., principal inspection officer, Ministry of Supply.

M.B.E. Gilbert Anderson, manager of welding and fabricating department, Bruce Peebles and Co., Ltd., Edinburgh; David S. Blaikie, technical assistant and clerk of works, Ministry of Works, serving at H.M. Embassy, Washington; Alfred J. Bolt, senior experimental officer, Admiralty; Antonin A. Brejcha, senior technical officer, operations development unit, British Overseas Airways Corporation; Jackson S. Chrisp, chief maintenance engineer, Consett Iron Co., Ltd., County Durham; F. H. Crocombe, M.M., district engineer, Minehead District, South Western Electricity Board; Major John B. Dodds, T.D., Corps of Royal Engineers; Donald Dunsmore, superintendent, Brush Electrical Engineering Co., Ltd., Loughborough; George A. Edwards, gauge design officer, Naval Ordnance Inspection Department, Admiralty; Donald Fairweather, chief of crystal production, Marconi's Wireless Telegraph Co., Ltd.; Captain Robert A. Foster, Corps of Royal Engineers; Edwin J. Franklin, works manager, Remploy Factory, Longton, Staffordshire; Walter Geary, assistant superintendent, Metropolitan-Vickers Electrical Co., Ltd., Manchester; Thomas W. Greaves, safety officer, Dunlop Rubber Co., Ltd., Birmingham; Frederick W. T. Hammett, principal production inspector, Admiralty; Arthur E. Hill, manager, Glass Works, British Thomson-Houston Co., Ltd., Chesterfield; Cecil L. Hunt, chief clerk, J. Jefferies and Sons, Ltd., Graving Dock Works, Avonmouth; George S. Jones, chief engineer, Grosvenor Chater and Co., Ltd., Abbey Paper Mills, Holywell, Flintshire; William A. Jones, manager, Radford and Wollaton Unit, East Midlands Division, National Coal Board; Sydney Knight, engineer II, Royal Aircraft Establishment, Ministry of Supply; Cyril C. Knowles, works manager, William McGeoch and Co., Ltd., Birmingham; Major Robert N. Legge, M.M., Corps of Royal Engineers; Charles J. Lever, works manager, Siemens, Brothers and Co., Ltd., West Hartlepool and Spennymoor, County Durham; Robert Lumley, labour manager, John Readhead and Sons, Ltd., South Shields, County Durham; Hector Macpherson, engineer II, Royal Aircraft Establishment, Ministry of Supply; Frank P. Macrae, manager of structural shops, Sir William Arrol and Co., Ltd., Glasgow; Frank Marriott, works manager, Head Wrightson Steel Foundries, Ltd., Stockton-on-Tees; Charles B. P. Morton, D.S.O., D.F.C., assistant to the chairman, Matthew Hall and Co., Ltd.; Thorald E. Naughton, superintending inspector, Aeronautical Inspection Service, Royal Air Force; Bertram S. Pears, production manager, Imperial Typewriter Co., Ltd., Leicester; William R. Peatling, apprentice supervisor, Telegraph Construction and Maintenance Co., Ltd., Greenwich; Sidney R. Peek, base engineer, Stratocruiser and Constellation Fleet, British Overseas Airways Corporation; Frederick S. Perry, assistant manager, English Steel Corporation, Ltd., Sheffield; Frederick J. Pewtner, chief designer, E. N. V. Engineering Co., Ltd., Willesden; Ernest E. Pheasey, works manager, Foster, Yates and Thom, Ltd., Blackburn; Edward W. Phillips, managing director, Air Schools, Ltd., Derby; Philip Phillips, civil assistant, Royal Naval Air Repair Yard, Fleetlands, Hampshire; William E. Phillips, chief draughtsman, Harland and Wolff, Ltd., Bootle, Lancashire; Melville J. Rattray, city engineer, Georgetown Municipality, British Guiana; Walter S. Read, manager, Fraser and Chalmers Engineering Works, Erith; William J. R. Richards, deputy superintendent, Directorate-General of Works, Air Ministry; Matthew Russell, chief engineer, Cerebos group of companies, Middlewich Salt Co., Ltd., Cheshire; Joseph F. Rust, general manager and engineer, Newport Undertaking, Wales Gas Board; John J. Sarche, chief inspector, Ultra Electric, Ltd., Acton; Raymond Spencer, engineer, Newark Area Internal Drainage Board; Major Walter Staples, Corps of Royal Engineers, Territorial Army; Herbert E. Toogood, assistant engineering manager, Humber St. Andrew's Engineering Co., Ltd., Hull; Henry E. Wasser, chief testing engineer, Midlands Division, British Electricity Authority; Thomas Whiting, group engineer, Northern Division, National Coal Board; Arthur W. Whittaker, senior executive engineer, Telecommunications, General Post Office; Major (Quantity Surveyor) (now temporary Lieutenant-Colonel) Wesley F. Willoughby, Corps of Royal Engineers; and Frank Wood, works manager, Turner Brothers Asbestos Co., Ltd., Hindley Green.

Obituary

LIEUT.-COLONEL H. P. T. LEFROY, D.S.O., M.C.

We regret to record the death of Lieut.-Colonel H. P. T. Lefroy, which occurred at Carrigglas Manor, County Longford, Ireland, on Sunday, December 26, at the age of 74.

Hugh Percival Thomson Lefroy, who was descended from a Huguenot family, was educated at Cheltenham College and at the Royal Military Academy, Woolwich. He obtained a Commission in the Corps of Royal Engineers in 1899; and served in the South African War, where he was engaged on railway work. After further military service in this country and at Gibraltar, he turned his attention to radio communication, then in the early stages of its development; and in 1909 was appointed head of an experimental section for developing Army field and aircraft wireless. For the next five years he carried out much useful research in this subject and good use was made of his knowledge during the 1914-18 war.

From 1920 to 1922 he held an appointment at the Signals Experimental Establishment, Woolwich, and after his retirement from the Army with the rank of lieutenant-colonel in the latter year, had charge of radio research work at the Air Ministry until 1927. During this period, he was also representative of the Ministry on the Radio Research Board and on the Committee of the Radio Section of the Institution of Electrical Engineers.

For his services during the 1914-18 war, in the course of which he served in France, Egypt, Salonika, Mesopotamia and Persia, he was awarded both the Distinguished Service Order and the Military Cross. He was also Chevalier of the Legion of Honour. He was elected an Associate Member of the Institution of Electrical Engineers in 1910.

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DR. T. W. CHALMERS

It was with much regret that we recorded in last week's issue the death, on December 22, of Dr. T. W. Chalmers, consultant editor of our contemporary, *The Engineer*, with which he had been associated for 45 years. He had been in poor health for a considerable period and for that reason had not been often seen at engineering and scientific gatherings for some time past, but the news of his death was not generally expected, for he was still quietly active until comparatively recently.

Thomas Wightman Chalmers was a native of Glasgow, where he was born on August 23, 1884, and received his general education at Hillhead High School and Glasgow High School. In 1901, he began an engineering apprenticeship in the Hyde Park Locomotive Works of Neilson and Company, later absorbed into the North British Locomotive Company, where he served both in the shops and in the drawing office. Between 1904 and 1908, he took the B.Sc. (Engineering) course in Glasgow University, graduating in the latter year with distinction in engineering subjects and in natural philosophy, and gaining a Walker Prize. He was also awarded a James Watt post-graduate scholarship, which he applied to an investigation of the specific heat of superheated steam, designing and constructing his own apparatus for the purpose.

On the conclusion of this work, he joined the staff of *The Engineer* as an assistant editor under the late Mr. Loughnan Pendred, eventually becoming chief assistant editor. During the first World War he edited the *Ministry of Munitions Journal* from 1916 to 1918. When, in 1946, Mr. Pendred retired and was succeeded by his son, Mr. B. W. Pendred, Chalmers was appointed consultant editor. His health, even then, was beginning to fail, but he continued to pursue the philosophical inquiries which had always been among his chief interests, typical of which was the series of *Historic Researches* which was published in book form in 1949. It was the last of several volumes in which he embodied the material of articles previously published serially, earlier works dealing with *The Production and Treatment of Vegetable Oils*, *Paper Making and Its Machinery*, and *The Gyroscopic Compass*. The theory of the gyroscope interested him greatly and it was for work on this subject, we understand, that he was awarded his D.Sc. degree by the University of Glasgow. He was a clear thinker and a lucid writer, knowledgeable on a wide range of topics, and a mathematician of considerable ability. He was a member of the Institution of Mechanical Engineers, to which he was elected as an associate member in 1910, being transferred to the grade of member 20 years later; and, though he seldom took part in discussions, his views—sometimes expressed with decided pungency, seasoned with a characteristic Scottish humour—were often sought by his numerous friends, to whom the fruits of his wide reading and extensive scientific knowledge were always freely available.

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We regret also to record the deaths of:

MR. WILLIE MILLS, on December 25, at the age of 66. Mr. Mills was a director, former secretary and oldest employee of Brook Motors Ltd., Empress Works, Huddersfield. He retired from the position of secretary in February, 1954, owing to failing health. Mr. Mills had been made a director in 1918 and remained on the board up till the time of his death.

MR. RALPH SAMUEL HARBORNE, M.Sc.(Bristol), F.R.I.C., M.I.Chem.E., on December 29, at the age of 57. Mr. Harborne was one of the founders of Base Metal Products Ltd., suppliers of lead oxide for accumulators, Wembley, Middlesex, established in 1932, and latterly had been chairman and joint managing director of the company.

ENGINEER REAR-ADMIRAL WILLIAM JOHN DIXON, on December 28, at the age of 79. He served as chief engineer of Simonstown Dockyard, South Africa, from 1923 until 1926, and, from 1926 until his retirement in 1929, as Admiralty Overseer in the Sheffield and Leeds districts.

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PERSONAL

SIR CHARLES BARTLETT, F.R.S.A., M.I.Mech.E., M.I.P.E., managing director of Vauxhall Motors Ltd., Luton, Bedfordshire, for 23 years and chairman since June, 1953, retired from the company on December 31, 1954. He is also relinguishing his seat on the board.

MR. J. S. JEFFREY resigned his position as joint managing director and retired from the board of the Woodall-Duckham Construction Co. Ltd., Woodall-Duckham House, 63-77, Brompton-road, London, S.W.3, on December 31, 1954. He will retain, however, his directorship of the parent company, Woodall-Duckham Ltd., and other directorships which he holds on behalf of the Woodall-Duckham Group. Mr. Jeffrey joined the staff of the company in 1912. MR. J. SIMPSON has been appointed joint managing director of the Woodall-Duckham Construction Co. Ltd., as from January 1.

MR. G. R. TYLER has retired from the position of manager of the Maritime Division of Marconi's Wireless Telegraph Co. Ltd., Chelmsford, Essex, but is continuing his work for the company as their representative in West Africa. Mr. Tyler's successor as manager, Maritime Division, is MR. B. G. H ROWLEY, M.A. (Oxon.), A.M.I.E.E.

MR. F. S. WHALLEY, M.C., M.I.Mech.E., M.I.Loco.E., is relinguishing his directorships of Vulcan Foundry Ltd., and of Robert Stephenson and Hawthorns Ltd.

MR. FREDERICK WALKER, O.B.E., M.I.Mech.E., chief engineer of the Dunlop Rubber Co. Ltd.. at Fort Dunlop, retired on December 31, 1954, after 40 years of service with the company.

MR. J. MCMILLAN, principal surveyor to Lloyd's Register of Shipping at Hull, retired on December 31, 1954, having reached pensionable age. His successor is MR. A. W. B. EDWARDS, hitherto a senior ship and engineer surveyor at Hull.

MR. F. NIXON, B.Sc.(Manc.), M.I.Mech.E., F.R.Ae.S., succeeded MR. E. J. CANTRILL as chief quality engineer, Aero-Division, Rolls-Royce Ltd., Derby, on Mr. Cantrill's retirement on December 31.

MR. F. R. JOLLEY, M.Sc., A.M.I.C.E., and MR. J. R. ROWLANDS, M.I.Mech.E., have been appointed joint managing directors of Simon Handling Engineers Ltd., Cheadle Heath, Stockport, Cheshire, with effect from January 1. MR. I. HEY, M.Sc.(Tech.), M.I.Mech.E., remains chairman of the company.

MR. T. E. LAING, who has been works manager and, more recently, general manager of the joint factories at Barry, Glamorgan, of British Resin Products Ltd., and British Geon Ltd., since they were built in 1947, has been elected a director of British Resin Products Ltd.

DR. W. D. SCOTT, who recently relinquished his appointment with Monsanto Chemicals Ltd., has joined British Tyre and Rubber Co. Ltd., Herga House, Vincent-square, London, S.W.1, as personal assistant to the managing director, MR. P. W. HOWARD.

MR. C. C. BIRCH has joined Guest Keen and Nettlefolds (Midlands) Ltd., and has been appointed general works manager of the screw division. He took up his appointment on January 3.

MR. HAMISH LITHGOW, general manager, Wallsend Shipyard, Swan, Hunter, and Wigham Richardson Ltd., is retiring after 49 years' service.

MR. H. C. THOMAS, M.M., director and secretary, Northern Aluminium Co. Ltd., Banbury, Oxfordshire, has retired. He joined the staff of the firm at the London office on January 1, 1925.

MR. ARCHIBALD ALEXANDER, C.A., secretary and a director of Scotts' Shipbuilding and Engineering Co., Ltd., Greenock, has retired.

MR. HILTON HUTCHINSON, manager of the Howdon-on-Tyne repair yard of the Tyne Improvement Commission, is retiring after upwards of 40 years of service at the yard.

MR. G. WATSON-WILLIAMS has accepted an appointment from the United Nations Technical Assistance Administration to serve as an industrial economist to the Government of Indonesia, at Djarkata. The appointment, which is for one year, has been made at the request of the Indonesian Government.

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COMMERCIAL

HEAD, WRIGHTSON & CO., LTD., Thornaby-on-Tees, have acquired the whole share capital of F. P. CAIRD & CO. LTD., 19, Waterloo-street, Glasgow. The name of the company is being changed to HEAD WRIGHTSON (SCOTLAND) LTD. The new directors are SIR JOHN WRIGHTSON, Bt., MR. PETER WRIGHTSON and MR. J. W. WARDELL. MR. J. T. YOUNG will be the official responsible for the operation of the Glasgow office.

As a consequence of the recent transfer of the POWELL DUFFRYN GROUP shareholding in the VACUUM OIL CO. LTD., to SOCONY-VACUUM OIL CO. INC., of New York, the five directors nominated by the Powell Duffryn Group, namely, SIR HERBERT MERRETT, SIR HENRY WILSON SMITH, K.C.B., K.B.E., MR. W. M. CODRINGTON, MR. M. B. REID, M.B.E., M.C., J.P., and MR. H. V. VALE, resigned on December 21, 1954, from the board of the Vacuum Oil Co. The company is now a wholly-owned subsidiary concern of Socony-Vacuum. On the invitation of that company, SIR HENRY WILSON SMITH and MR. M. B. REID have been re-elected to the board of the Vacuum Oil Co. Ltd., which now consists of MR. J. C. GRIDLEY, C.B.E. (chairman), MR. H. W. ROCKE (managing director) and MR. C. LAWRIE, MR. J. B. MIDDLETON, MR. M. B. REID, SIR HENRY WILSON SMITH, and MR. J. S. VESEY BROWN.

Representation for the full range of the compressed-air products of the CONSOLIDATED PNEUMATIC TOOL CO. LTD., 232, Dawes-road, London, S.W.6, in the British West African territories, has been arranged with the UNITED AFRICA CO. LTD., Unilever House, London, E.C.4, with offices in the Gold Coast at Accra, Takoradi and Kumasi, and offices in Nigeria at Kaduna, Lagos and Enugu. MR. P. J. DARNELL has been appointed resident technical representative.

DAVIES & METCALFE LTD., Injector Works, Romiley, near Manchester, have acquired the sole rights to manufacture and sell, in the United Kingdom and the Commonwealth, a new and improved design of air-braking equipment for railway locomotives. The equipment has been developed by the OERLIKON ENGINEERING COMPANY, Zürich, and prolonged tests have been carried out by a number of European railways.

An agreement has recently been signed between NORTH EASTERN TRADING ESTATES LTD. and the RANSOME AND MARLES BEARING CO. LTD., Newark-on-Trent, for an immediate extension to their new factory, opened in 1953, at Annfield Plain, Co.

Durham. The inauguration of the factory was described in ENGINEERING, vol. 176, page 467 (1953).

To safeguard the body-supply position of their Automobile Division, for both Aston Martin and Lagonda cars, the DAVID BROWN COMPANIES have acquired TICKFORD LTD., coach builders, Newport Pagnell, Buckinghamshire. MR. I. I. BOSWELL is to remain as managing director. It is planned to develop production facilities at Newport Pagnell. The London branch of Tickford Ltd. is not included in the transfer and will continue its business as at present.

WICKMAN LTD., and WILD-BARFIELD ELECTRIC FURNACES LTD., announce that agreement has been reached between the two companies whereby the induction-heating business of Wickman Ltd. has been acquired by Wild-Barfield as from January 1. The manufacture of the plant will continue at the existing address at Oxgate-lane, Cricklewood, London, N.W.2, for the present, after which it will be transferred to the Wild-Barfield Works at Watford. MR. F. L. GLADWIN of Wickman Ltd. has been appointed sales manager of the Wild-Barfield induction-heating department.

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HONOURS LIST

Many engineers, industrialists and scientists are among those whose names are contained in the New Year Honours List, published on January 1. Included among them are those mentioned below.

Barons

Edgar Douglas Adrian, O.M., President of the Royal Society, President of the British Association, and Master of Trinity College, Cambridge; and Sir William Fraser, C.B.E., chairman of the Anglo-Iranian Oil Co., Ltd.

Privy Councillor

Evelyn Nigel Chetwode Birch, O.B.E., M.P., Minister of Works since October, 1954.

Knights Bachelor

Ivor R. Cox, D.S.O., for services as managing director, Metropolitan-Vickers Electrical Co., Ltd.; Robert A. Maclean, for services to industry in Scotland; Philip E. Millborn, C.M.G., honorary adviser on shipping in port to the Minister of Transport and Civil Aviation; Keith A. H. Murray, chairman, University Grants Committee; Wilfred J. Neden, C.B., C.B.E., Chief Industrial Commissioner, Ministry of Labour and National Service; Sydney G. Russell, C.B.E., M.C., designer and artist; Leonard Sinclair, chairman and managing director, Esso Petroleum Co., Ltd.; Rear-Admiral Matthew S. Slattery, C.B. (ret'd.), chairman and managing director, Short Brothers and Harland, Ltd., Belfast; Henry Spurrier, managing director, Leyland Motors Ltd.; and Oliver G. Sutton, C.B.E., director of the Meteorological Office, Air Ministry.

Order of the Bath

G.C.B. Sir John P. R. Maud, K.C.B., C.B.E., Permanent Secretary, Ministry of Fuel and Power.

K.C.B. Vice-Admiral (E) Frank T. Mason, C.B.

C.B. Rear-Admiral (E) John G. C. Given, C.B.E.; George R. D. Hogg, C.B.E., Under-Secretary, Department of Scientific and Industrial Research; William R. McGaw, director general of aircraft production, Ministry of Supply; Rear-Admiral (E) Philip C. Taylor; Major-General Leslie N. Tyler, O.B.E., R.E.M.E.

Order of Saint Michael and Saint George

C.M.G. Theodore L. Bowring, O.B.E., director of public works, Hong Kong; John F. R. Hill, member for communications, works and development planning, Tanganyika; Edward W. Senior, commercial director, British Iron and Steel Federation.

Queen's Commendation for Valuable Service in the Air

Mrs. Anne Burns, principal scientific officer, Royal Aircraft Establishment, Ministry of Supply. (Church Crookham, Hampshire.)

Order of the British Empire

K.B.E. Sir (Arthur) Wilfrid Garrett, chairman, Industrial Injuries Advisory Council; Owen H. Wansbrough-Jones, C.B., O.B.E., chief scientist, Ministry of Supply; and Eric A. Seal, C.B., deputy secretary, Ministry of Works.

C.B.E. Risdon A. Beazley, chairman and managing director, Risdon Beazley, Ltd., Southampton; John Beaumont, O.B.E., A.F.C., Commandant, Technical Training College, Indian Air Force, Jalahalli, India; David Blee, chief of commercial services, British Transport Commission; Charles S. Bryant, lately director of materials, and explosives research and development, Ministry of Supply; Brigadier (temporary) Geoffrey E. Butler, R.E.M.E.; Herbert A. Campbell, O.B.E., for services to the rubber industry in Malaya; Brigadier (temporary) Laurence F. de V. Carey, late Corps of Royal Engineers; Lewis Chapman, managing director, William Jessop and Sons, Ltd., Sheffield; John C. Clark, M.C., Director of the Rural Industries Bureau; Isaac W. Cumberbatch, O.B.E., chairman, West Midlands Division, National Coal Board; Colonel (temporary) Eric P. Dickson, Corps of Royal Engineers; Colonel (temporary) Henry Grattan, Corps of Royal Engineers; Frederick W. Halliwell, President of the Gauge and Tool Makers' Association; Harold W. Hobbs, director of ordnance factories, Nottingham, Ministry of Supply; Frederick J. C. Honey, secretary, British Employers' Confederation; Horace E. Jackson, lately President, British Non-Ferrous Metals Federation; Miss Dorothy Johnson, deputy chief inspector of factories, Ministry of Labour and National Service; William E. C. Lazenby, lately member of the Industrial Court; Neil C. Macnamara, chairman and managing director, Trollope and Colls, Ltd., London; Brigadier Kenneth Mackay, D.S.O., O.B.E., late Corps of Royal Engineers; Cecil T. Melling, chairman, Eastern Electricity Board; George Ormiston, superintendent engineer, New Zealand Shipping Co. Ltd., and Federal Steam Navigation Co., Ltd.; Alfred H. Parker, Assistant Director of Dockyards, Admiralty; Victor A. Patterson, J.P., deputy chairman and managing director, J. and E. Hall, Ltd., Dartford; David A. Shirlaw, Director of Administration and Accounts, Atomic Energy Authority; Professor Charles H. Smith, Department of Instrument Technology, Royal Military College of Science; Group Captain John B. Veal, A.F.C., Aviation Safety and Licensing, Ministry of Transport and Civil Aviation; Alfred Watson, chief mechanical and electrical engineer, Air Ministry; George S. Wells, M.C., deputy chief engineer, Ministry of Housing and Local Government; and Major Francis R. B. Whitehouse, M.B.E., chairman and managing director, Chad Valley Co., Ltd., Birmingham.

O.B.E. Harold J. Atkinson, area general manager, North Eastern Division, National Coal Board; George W. Bain, chief engineer, S.S. "Mauretania," Cunard Steamship Co., Ltd.; Lieutenant-Colonel Herbert H. Broadbent, T.D., R.E.M.E., Territorial Army; Lieutenant-Colonel the Right Honourable Edward Southwell, Baron de Clifford, T.D., R.E.M.E.; Robert Connor, director and general Manager, Measurement, Ltd., Oldham, Lancashire; Commander (E) Frederick J. S. Corney, R. N. (retd.); George Daly, M.B.E., staff controller, Engineering Department, General Post Office; Herbert Duckworth, superintending electrical engineer, Admiralty Engineering Laboratory, West Drayton; William J. Dyer, resident engineer, Hanningfield Reservoir, Essex; G. D. Elliott, works manager (iron), Appleby-Frodingham Branch, United Steel Companies Ltd., Sheffield; Wynn H. Evans, principal scientific officer, Safety in Mines Research Establishment, Ministry of Fuel and Power; William J. Felton, secretary, Institution of Mining and Metallurgy; Alfred E. Gollop, assistant director of storage, Ministry of Supply; Frederic A. Gould, lately senior principal scientific officer, National Physical Laboratory, Department of Scientific and Industrial Research; A. S. Hartshorn, recently scientific attaché, H.M. Embassy, Paris (now principal scientific officer, Royal Aircraft Establishment, Farnborough); Gerald A. Hill, director, Higgs and Hill, Ltd., Crown Works, London; Arthur T. Horton, principal scientific officer, Ministry of Defence; Professor Leslie Howarth, Department of Applied Mathematics, University of Bristol; Ronald C. Kelt, M.B.E., engineer-in-chief and inspector-general of ports and navigation, Basra; Herbert J. Jones, technical consultant, Hemingway and Co., Ltd.; Herman R. Lindars, for services in the field of fuel efficiency; Captain John H. J. Martin, works manager, Elswick and Scotswood Works, Vickers-Armstrongs, Ltd.; Alan S. Milward, deputy chief engineer, office of Crown Agents for Overseas Governments; James A. F. Morrison, M.M., city quantity surveyor, Dundee; Peter Philip, area manager, Dundee, North of Scotland, Hydro-Electric Board; Donald H. Reed, superintending examiner patent Office, Board of Trade; Geoffrey H. G. Richards, Director, Mechanical Transport Department, Sudan Government; Harold Ringshaw, chief engineer, R.F.A. Service; Eric L. Ripley, principal scientific officer, Structures Department, Ministry of Supply; Vernon W. M. Roberts, Electronics Department, British Thomson-Houston Co., Ltd., Rugby; Lieutenant-Colonel Roy C. Salmon, R.E.M.E.; Jack Shackleton, engineering superintendent of design, Atomic Energy Authority; John L. Sharratt, borough engineer and surveyor, Shoreditch; William J. Shea, M.B.E., principal, Ministry of Transport and Civil Aviation; Robert Spence, director and general manager, John Hastie and Co., Ltd. Greenock; Donald Todd, Deputy Director of Armament Supply, Admiralty; George A. Vowles, divisional controller, Yorkshire Division, British Electricity Authority; Professor Frederick V. Warnock, Head of the Department of Mechanical Engineering, Belfast Municipal College of Technology; Norman H. A. Warren, senior principal scientific officer, Admiralty Gunnery Establishment, Portland; David Watson, Principal, Ministry of Works; and William H. Yoxall, G.M., principal inspection officer, Ministry of Supply.

M.B.E. Gilbert Anderson, manager of welding and fabricating department, Bruce Peebles and Co., Ltd., Edinburgh; David S. Blaikie, technical assistant and clerk of works, Ministry of Works, serving at H.M. Embassy, Washington; Alfred J. Bolt, senior experimental officer, Admiralty; Antonin A. Brejcha, senior technical officer, operations development unit, British Overseas Airways Corporation; Jackson S. Chrisp, chief maintenance engineer, Consett Iron Co., Ltd., County Durham; F. H. Crocombe, M.M., district engineer, Minehead District, South Western Electricity Board; Major John B. Dodds, T.D., Corps of Royal Engineers; Donald Dunsmore, superintendent, Brush Electrical Engineering Co., Ltd., Loughborough; George A. Edwards, gauge design officer, Naval Ordnance Inspection Department, Admiralty; Donald Fairweather, chief of crystal production, Marconi's Wireless Telegraph Co., Ltd.; Captain Robert A. Foster, Corps of Royal Engineers; Edwin J. Franklin, works manager, Remploy Factory, Longton, Staffordshire; Walter Geary, assistant superintendent, Metropolitan-Vickers Electrical Co., Ltd., Manchester; Thomas W. Greaves, safety officer, Dunlop Rubber Co., Ltd., Birmingham; Frederick W. T. Hammett, principal production inspector, Admiralty; Arthur E. Hill, manager, Glass Works, British Thomson-Houston Co., Ltd., Chesterfield; Cecil L. Hunt, chief clerk, J. Jefferies and Sons, Ltd., Graving Dock Works, Avonmouth; George S. Jones, chief engineer, Grosvenor Chater and Co., Ltd., Abbey Paper Mills, Holywell, Flintshire; William A. Jones, manager, Radford and Wollaton Unit, East Midlands Division, National Coal Board; Sydney Knight, engineer II, Royal Aircraft Establishment, Ministry of Supply; Cyril C. Knowles, works manager, William McGeoch and Co., Ltd., Birmingham; Major Robert N. Legge, M.M., Corps of Royal Engineers; Charles J. Lever, works manager, Siemens, Brothers and Co., Ltd., West Hartlepool and Spennymoor, County Durham; Robert Lumley, labour manager, John Readhead and Sons, Ltd., South Shields, County Durham; Hector Macpherson, engineer II, Royal Aircraft Establishment, Ministry of Supply; Frank P. Macrae, manager of structural shops, Sir William Arrol and Co., Ltd., Glasgow; Frank Marriott, works manager, Head Wrightson Steel Foundries, Ltd., Stockton-on-Tees; Charles B. P. Morton, D.S.O., D.F.C., assistant to the chairman, Matthew Hall and Co., Ltd.; Thorald E. Naughton, superintending inspector, Aeronautical Inspection Service, Royal Air Force; Bertram S. Pears, production manager, Imperial Typewriter Co., Ltd., Leicester; William R. Peatling, apprentice supervisor, Telegraph Construction and Maintenance Co., Ltd., Greenwich; Sidney R. Peek, base engineer, Stratocruiser and Constellation Fleet, British Overseas Airways Corporation; Frederick S. Perry, assistant manager, English Steel Corporation, Ltd., Sheffield; Frederick J. Pewtner, chief designer, E. N. V. Engineering Co., Ltd., Willesden; Ernest E. Pheasey, works manager, Foster, Yates and Thom, Ltd., Blackburn; Edward W. Phillips, managing director, Air Schools, Ltd., Derby; Philip Phillips, civil assistant, Royal Naval Air Repair Yard, Fleetlands, Hampshire; William E. Phillips, chief draughtsman, Harland and Wolff, Ltd., Bootle, Lancashire; Melville J. Rattray, city engineer, Georgetown Municipality, British Guiana; Walter S. Read, manager, Fraser and Chalmers Engineering Works, Erith; William J. R. Richards, deputy superintendent, Directorate-General of Works, Air Ministry; Matthew Russell, chief engineer, Cerebos group of companies, Middlewich Salt Co., Ltd., Cheshire; Joseph F. Rust, general manager and engineer, Newport Undertaking, Wales Gas Board; John J. Sarche, chief inspector, Ultra Electric, Ltd., Acton; Raymond Spencer, engineer, Newark Area Internal Drainage Board; Major Walter Staples, Corps of Royal Engineers, Territorial Army; Herbert E. Toogood, assistant engineering manager, Humber St. Andrew's Engineering Co., Ltd., Hull; Henry E. Wasser, chief testing engineer, Midlands Division, British Electricity Authority; Thomas Whiting, group engineer, Northern Division, National Coal Board; Arthur W. Whittaker, senior executive engineer, Telecommunications, General Post Office; Major (Quantity Surveyor) (now temporary Lieutenant-Colonel) Wesley F. Willoughby, Corps of Royal Engineers; and Frank Wood, works manager, Turner Brothers Asbestos Co., Ltd., Hindley Green.

EFFECT OF ACCIDENTS ON LABOUR FORCE

REPORT OF CHIEF INSPECTOR OF FACTORIES FOR 1953

In 1953 there were more accidents in factories than in 1952. This was the most important fact in the Annual Report of the Chief Inspector of Factories for 1953,* published in December, 1954. Sir George Barnett, the Chief Inspector, attributes it to the increase in the working population within the scope of his report, and to the greater number of man-hours worked during the year. The trend since the war had been for the number of accidents to decrease year by year, but the number increased from 177,510 in 1952 to 181,637 in 1953, an increase of 2·33 per cent.; the number of fatal accidents decreased from 796 to 744. Other points in the report were: the effects of increased use of radio-active substances in industry; the disturbing way in which accidents to young workers had increased; methods of preventing accidents; the increasing use of low-voltage portable tools; an interesting experiment to alleviate shortage of labour at a toffee factory.

The report stated that managements in industry generally had shown that they held themselves responsible for protecting their workers against dangerous radiations arising from the use of radio-active substances. Gamma rays from a number of elements, among which were Cobalt 60, Tantalum 182, Iridium 192, and Thulium 170, were being increasingly used, and the use of X-rays was still further increased. Rooms containing X-ray sets monitored by the Inspectorate were found to be protected to a standard well above the minimum necessary. The Report described the protection of X-ray mobile sets for use where articles were too large, heavy or generally inconvenient to move to a central X-ray room. In one case a radiation pit was being constructed, the first of its kind in this country, the floor of which would be some 20 ft. below factory floor level. The use of personal pocket dosemeters for workers engaged regularly in gamma radiographic work was on the increase, and it was hoped that eventually all workers would be so equipped as a matter of course, since these instruments enabled " on the spot " readings to be taken at any moment of the amount of gamma radiation absorbed by the body. There was an encouraging response by manufacturers to the Department's suggestion that containers and housings of radio-active substances should be distinguished by orange markings as an aid to easy identification and care in handling.

THE PERILS OF YOUTH

The report was particularly concerned with accidents to the young; young workers under 18 should be well supervised to prevent easily avoidable accidents. A few accidents were caused by the naturally adventurous spirit of the young, but in many cases the adventurous spirit should be curbed by admonition or example. Without doubt, lack of supervision and absence of a feeling of responsibility for young workers caused many unnecessary accidents during 1953. One boy was crushed between two railway trucks when crossing a railway siding on an unauthorised coal-picking expedition; lack of supervision could not be blamed for his death. But in one case during the tea break in a steelworks the " spare lad " fell off the sloping roof of a building into the river and broke his leg; it transpired that several of the boys were in the habit of basking on this roof, and that foremen and other workers had done little to prevent them. If the foremen had pointed out the danger to the boys, or taken steps to prevent them going on the roof, the accident could have been avoided. Older workers could also set an example of safe working to the young which might have a better and more lasting effect than admonition. The disturbing fact in the Report was that accidents to boys and girls had increased, and in the case of boys the accident rate was approaching that of men. Sir George Barnett made the following statement last year, and this year it is even more appropriate: " Allowing young workers to be injured or killed is a form of extravagance in which British industry simply cannot afford to indulge; the supply of juvenile labour which will be available during the next decade can be forecast accurately; it is well known that it will be inadequate and that no wastage can be made good. Young workers in fact constitute industry's most precious raw material, and employers would do well to ask themselves if they are watching over it with all the care that it needs."

* Annual Report of the Chief Inspector of Factories for the Year 1953. H.M. Stationery Office (6s. 6d.).

ACCIDENT PREVENTION

The Report indicated that there had been considerable improvement in accident prevention organisations all over the country. Sometimes this had been under the regrettable stimulus of serious accidents and prosecutions, but much had been achieved gradually by progressive managements, keen safety officers, active works committees, and the inspiration of the Royal Society for the Prevention of Accidents. At one large iron and steel works the safety arrangements were reorganised, and three special committees were set up: a managers' accident-prevention committee which met monthly and was limited to departmental managers together with the safety officer and personnel manager; an engineers' accident-prevention committee, which comprised all the works engineers responsible for departments of the steel works and ancillary factories such as brickworks, coke ovens, etc.; a joint accident-prevention committee which embraced representatives from the two previously-mentioned committees, together with representatives of the foremen and the workmen, this being a big committee which met monthly. In addition to setting up these committees, two safety officers were appointed, a publicity campaign was held, and every accident in the works had to be fully investigated and a report submitted to the managing director within twenty-four hours of the accident. These methods might seem elaborate, but precautions taken by the metal manufacturing industry had had the result that it was the only major industry in which the number of accidents was less in 1953 than in 1952.

There were 744 electrical accidents during the year, of which 70 were fatal; these numbers only included accidents which must be reported under the Factories Act, but another 86 deaths due to electrical accidents were made known to the Department. Many of the accidents were caused by portable apparatus, and in most cases the working pressure of the apparatus was greater than 200 volts. It was reported that many large organisations were changing the voltage of all their portable apparatus to 110 volts with mid-point earthing, and in some cases to 50 volts with mid-point earthing. The use of 110 volts for portable tools was widespread in the electricity supply industry, and was almost universal on building contracts placed by the British Electricity Authority.

The Report made some general observations on the health of industrial workers. It was difficult to separate the influence of the factory from the influence of home on any worker's state of health, but there were certain amenities in a factory which would undoubtedly contribute to good health; among these were good sanitary facilities, canteens, first-aid centres and medical services. One interesting point made was that short breaks in working spells for refreshment lessened fatigue and provided necessary stimulant, while the worker who got up at the last moment to go breakfastless to work had some opportunity for a snack and a hot drink. This could help in accident prevention, because a worker was more likely to have an accident when he was tired.

The Factory Inspector has power to limit the hours worked by women and boys and girls, and a number of prosecutions were made during the year. Hours of employment for men are not governed by the Factories Act, but one interesting development was reported. A toffee-making company needed workers for the wrapping machines, but could find no women workers. They therefore recruited a night shift of men, varying in age from the late fifties to the late sixties, including retired Civil Servants, Army officers and others with no previous industrial experience. The experiment was extremely successful, and the firm considered extending the system.

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CONTRACTS

Turbo-Generator. The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2, inform us that the BRITISH GENERAL ELECTRIC CO. (PROPRIETARY) LTD., South Africa, have received a contract from the Municipality of Bloemfontein for a further 10-MW turbo-generating set, complete with ancillary apparatus. Two similar machines ordered previously are in course of erection. The consultants to the Municipality are MERZ AND MCLELLAN (SOUTH AFRICA), Escom House, Rissik-street, Johannesburg.

Colliery Equipment. An order for the complete pit-top decking and mine-car circulating plant at Glyncorrwg South Pit in No. 2 Area of the National Coal Board (South Western Division) has been secured by HUMPHREYS AND GLASGOW, LTD., Humglas House, Carlisle-place, London, S.W.1. The plant will be hydraulically operated throughout and will include decking lifts and car-cleaning plant of advanced design. The contract includes the buildings and structural steelwork.

Air Liners. The British European Airways Corporation are to take delivery of two DE HAVILLAND Heron Mk. I feeder air liners in February to replace two de Havilland 89A Islander-class biplanes which have been in service with the Corporation's air-ambulance unit in Scotland since 1946. The Heron is a low-wing all-metal monoplane powered by four de Havilland Gipsy Queen-30 engines of 250 b.h.p., driving constant-speed propellers. Alterations have been made to the cabin interior so that two stretchers mounted on a tubular frame can be easily moved.

Water Tunnel and Intake Weir. Work on the construction of an intake weir at Glen Finglas and a tunnel 2½ miles long, through the slopes of Ben A'an, to Loch Katrine, part of a project which will make a notable addition to the resources of the Glasgow Corporation waterworks at Loch Katrine, is to begin shortly. The tunnel aqueduct 8 ft. in diameter and the intake weir in the River Turk will direct water into Loch Katrine. The contract for the tunnel and weir, amounting to £544,882, has been placed with A. A. STUART AND SONS (GLASGOW) LTD. It is expected that the works will take about three years to complete.

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HYDRO-ELECTRIC WORK IN SCOTLAND

The Secretary of State for Scotland (the Rt. Hon. J. Stuart, M.P.) has confirmed a scheme, prepared by the North of Scotland Hydro-Electric Board, for augmenting the supply of electricity to Fort William and the surrounding district.

The scheme will make use of the flow of water through the Mucomir Cut, an artificial channel which was constructed to take the outflow from Loch Lochy, apart from that which was required by the Caledonian Canal. Water will be led from this cut through a short tunnel to a generating station with a capacity of 1,500 kW on the north bank of Loch Lochy. A fish pass to allow the salmon to reach Loch Lochy will also be constructed.

BOOK REVIEWS

The Technical Report. Its Preparation, Processing and Use in Industry and Government. Edited by B. H. WEIL. *Reinhold Publishing Corporation*, 330 *West 42nd-street, New York 36, N.Y., U.S.A.* (12 dols.); and *Chapman and Hall, Limited*, 37 *Essex-street, London, W.C.2.* (96*s.*)

"We are in danger of building a Tower of Babel," wrote Dr. Vannevar Bush in a recent article, and the present volume contributes powerful evidence concerning the perils inherent in current technical reports. Mr. Weil, Manager of the Ethyl Corporation's Research and Engineering Department Information Services, has gathered round him an impressive group of specialists, drawn partly from his own firm and partly from other important American industrial and Government organisations, as well as from the universities and the research institutions. Together they have tackled every aspect of the technical report: functions, preparation and processing, distribution, filing and use. The needs of Government as well as of industry are given full consideration, and attention is paid to oral as well as to written material.

One of the most interesting features of this large volume is a facsimile reprint of the report manual of the Georgia Institute of Technology Engineering Experiment Station, which points out that "reports are the end products of actual research, the intermediaries between the laboratory and some new product or process." Clarity of writing is emphasised both here and throughout the book, and Professor Davis devotes 33 pages to common faults—ranging from jargon to "fused" sentences, and from "dangling modifiers" to cacophony— though British readers may prefer Sir Ernest Gowers's *Complete Plain Words* (H.M. Stationery Office, 1954) and R. W. Bell's *Write What You Mean* (Allen and Unwin, 1954) on this particular aspect.

This is a comprehensive work and in some respects is perhaps more detailed than would be considered necessary in this country. But it has a value not only as a practical manual but also as a reference book. There is, for example, a very useful 70-page illustrated summary of modern methods of illustration, duplication and binding, with some hints on the cleaning-up and simplification of illustrations, while Mr. Lane's chapter on making graphs and tables more effective is a convincing visual guide to a difficult subject. Users of American Government documents will find Miss Patricia L. Brown's tabulated summary on pages 394 to 400 a convenient quick-reference source; and the comprehensive bibliographies appended to the chapters provide an up-to-date guide to recent British and American literature in this field. Readers may also be interested in the description of the activities of the United States Information Service and of the London Branch of the Office of Naval Research, as well as in the discussion of security controls.

At a recent ASLIB Conference it was pointed out that instant accessibility was even more important than economy in the storage of reports: the chapter on filing keeps this point well in mind as it explores the aid to be gained from indexes, punched cards, uniterm coordinate indexing, and the use of microphotography—including a skilful combination of punched cards and microfilm. In this connection the 20 hindrances to the use of technical files (pages 386 to 387) have an international application and repay study.

Both Mrs. Graham and the Georgia Institute manual recommend that glossaries should be placed among the appendices to the report. Experience proves, however, that in such a position they are in danger of being overlooked, and that their inclusion in the prefatory matter—next to, or incorporating any list of abbreviations used—is more desirable.

The different chapters vary very much in readability but the editing has been well done, there is a little overlapping and references to related material elsewhere are frequently made. Based on a symposium presented to the Division of Chemical Literature of the American Chemical Society in September, 1953, the present text—covering a wider subject—abounds in experience and original ideas. In spite of the price which puts it out of the reach of many individuals and libraries able to make good use of it, this well-produced handbook is worth acquiring by all those concerned in the frequent production or employment of technical reports.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Power Transmission and Conveying Equipment. THE LINK-BELT COMPANY, 307 N. Michigan-avenue, Chicago 1, Ill., U.S.A. Catalogue of standard products, divided into six sections containing details of chains, enclosed drives, bearings, couplings and transmission products, processing equipment, conveyors, and auxiliary products. The catalogue is provided with a thumb-index for quick reference to the principal sections and sub-sections, and has a detailed alphabetical index at the end. The sections relating to chains and enclosed drives are prefaced by technical information on the selection of suitable equipment from the large range listed, and similar information is contained in tabular and textual form throughout the book. Processing equipment includes screens of various types and ice-crushing and slinging machines. The conveyors listed include screw, oscillating, apron, belt, trolley and bucket-elevator types, and a full range of ancillary equipment for conveyors is illustrated. Winches, wheels, bin and hopper gates and cut-off valves are included. A short section at the end of the catalogue illustrates other equipment such as separators, classifiers, driers and coal-preparation plant.

Gas Condensers. SIMON-CARVES, LTD., Cheadle Heath, Stockport. The design of gas condensers. The necessity for gas cooling is discussed, and different types of condenser—the old atmospheric, the vertical and horizontal tube patterns and the direct-contact cooler—are described. Technical data on condenser design for specified duties are given. To replace the empirical rules formerly used for determining surface areas, graphs are provided to enable a condenser to be designed for specified conditions with a high degree of accuracy. The use of the data provided is illustrated by a typical design problem worked out in detail. An illustrated booklet of a high technical standard.

Aluminium. ALUMINIUM UNION LTD., The Adelphi, London, W.C.2. Aluminium applications as flat and coiled sheet for roofing, small sailing craft and components for irrigation fittings. Three illustrated leaflets discussing advantages of aluminium for these purposes and quoting instances of successful practice.

Measuring Instruments. METRON, Stockholm. Agents: C. E. JOHANSSON LTD., Southfields-road, Dunstable. Precision dial indicator; examples of standard dials and details of design; depth gauge with dial indicator; vernier height gauge. Five illustrated leaflets.

Class H Transformer. BRENTFORD TRANSFORMERS, LTD., Kidbrook Park-road, London S.E.3. Transformers with class H insulation using silicones and glass fibre for operation under high temperatures and arduous conditions. Booklet giving particulars of performance.

Industrial Canteens. INTEL (CATERERS) LTD., 2 Parkshot, Richmond. Notes written by Mr. H. N. Black on industrial canteens; provision, promotion of use, price-fixing. Booklet.

Girder Clip Assemblies. AITON & Co. LTD., Derby. Supplement to earlier publication, "Supports for Pipework"; types, dimensions and loads. Illustrated pamphlet.

BOOKS RECEIVED

Some of the books noticed in the Books Received column are selected for extended review in later issues of ENGINEERING.

Concrete Shell Roof Construction. Edited by P. J. WITT. *Cement and Concrete Association, 52 Grosvenor-gardens, London, S.W.1.* (30*s.*)

This book contains the Proceedings of a symposium held in London in July, 1952. The symposium was divided into three sessions comprising the architectural aspects, design and research, and construction and formwork. The Proceedings contain the original papers and both verbal and written discussion. In addition, a comprehensive bibliography has been included.

World Railways, 1954-55. Edited and compiled by HENRY SAMPSON. Third edition. *Sampson Low's "World Railways" Limited, 25 Gilbert-street, London, W.1.* (84*s.*)

In the new edition of this book, the sections on the older motive power and rolling stock, which can be referred to in earlier editions, have been omitted. Their place is taken by an enlarged railway section, and several new sections including underground railways, motive power and rolling stock manufacturers, diesel engines, and descriptive articles on developments of topical interest in different specialised fields of rail transportation.

Directory of Welding and Fabricating Equipment. Section I: Metal Arc Welding Electrodes. Reprinted from "Welding and Metal Fabrication." *The Louis Cassier Company, Limited, Dorset House, Stamford-street, London, S.E.1.* (3*s.* 6*d.*).

This directory is divided into five parts dealing with electrodes for arc welding mild steel, alloy steels, cast iron, non-ferrous metals, and for hard-facing. The electrodes are grouped under the name of the respective manufacturer, and the main details are given for each electrode, together with any special features.

Rules for the Unit Testing of Circuit-Breakers for Making-Capacity and Breaking-Capacity. *The Association of Short-Circuit Testing Authorities, 36 Kingsway, London, W.C.2.* (10*s.*).

With the increase in the voltage to be controlled, full scale testing of circuit-breakers, although desirable, is often impracticable. To overcome this difficulty the Association of Short-Circuit Testing Authorities recommends the system of unit testing. This publication describes the principles on which this method is based and the rules that have been formulated for carrying it out. In future, tests made by ASTA on high-voltage and high breaking-capacity circuit-breakers will be in accordance with these rules.

Problems Relating to the Development of Internal Combustion Engine Industry in India. *Council of Scientific and Industrial Research, New Delhi, India.* (No price given.)

This book contains the Proceedings of a symposium held at the Indian Institute of Science, Bangalore, in April, 1952. The papers presented were classified into three groups: (1) those relating to research and development carried out in India by the authors; (2) those reviewing recent developments abroad; and (3) those presenting proposals for future investigation and development in India. Papers of the first category are given in detail in the Proceedings, while papers in the other two groups are presented in summarised form.

Formulas for Computing Capacitance and Inductance. By CHESTER SNOW. U.S. National Bureau of Standards Circular 544. *The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A.* (40 cents.)

Formulæ are given for the computation of the capacitance between conductors having a great variety of geometrical configurations; the inductance, both self- and mutual, of circuits of various shapes; and the electrodynamic forces acting between coils when carrying current. Formulæ for skin effect and proximity effect in concentric cables and parallel wires are included.

Production Tooling Equipment: The Design of Jigs, Tools and Gauges. By S. A. J. PARSONS. *Cleaver-Hume Press, Limited, 31 Wright's-lane, Kensington, London, W.8.* (25*s.*)

This book is based on lectures delivered to advanced students at the College of Technology, Birmingham. It can be divided into four parts, the first two dealing with the design of drilling jigs and fixtures respectively, the third part dealing with cutting tools and tool layouts for various production machines, and the last part covering the design of gauges commonly used for production purposes. The book is officially approved for the Associate Membership examination of the Institution of Production Engineers.

The Engineering Outlook—1

BRITAIN'S PLACE IN WORLD ENGINEERING

I—OUTPUT AND MARKETS

The year 1954 has proved to be much better than most manufacturers in the engineering industry dared to hope at the outset. Sales of consumer goods were then already at high levels, but orders for capital goods such as machine tools, textile machinery, ships and commercial vehicles had fallen off considerably. There was no indication that industry at home was likely to increase investment in plant and machinery, although at current levels it was admittedly inadequate. There was also considerable danger of a fall in demand for consumer goods since there seemed to be a real possibility that the threatening slump in the United States might become world-wide. In the event, that recession was confined to the North American continent, and economic activity in the rest of the world expanded considerably.

Industrial production rose by 7 per cent. in 1954 and output of engineering products by rather more. The trend is shown in the upper diagrams on the opposite page. The largest increase was in output of vehicles, particularly passenger cars, nearly as many of which were produced in the first three-quarters of 1954 as in the whole of 1953. Output of most types of durable consumer goods (boosted by the relaxation of hire-purchase restrictions) also increased considerably, and—more important for the future of the British economy—there was a marked improvement in the flow of orders for capital plant and machinery. Official statistics are not very helpful, but there are grounds for believing that the increase in deliveries of plant and machinery to home and export markets may have been about 4 per cent. in 1954.

Whether or not gross capital formation at home is as yet adequate, productivity has been rising; the 7 per cent. rise in industrial production in 1954 was obtained from a working population only 2 per cent. greater than in 1953, which suggests that output per man rose by about 5 per cent. Rising productivity has enabled British industry to meet a larger wages bill with little or no increase in total costs: the Board of Trade index of wholesale prices rose by only 1 per cent., whereas wages went up by 5 per cent. Profits have been good, and the general mood of confidence is reflected in the record prices of industrial shares, which according to Moody's Index had risen by nearly 42 per cent. between October, 1953, and October, 1954.

Although the increase in industrial production may have derived slightly more from home than from export demand, the rise of 6 per cent. in exports greatly strengthened the foreign account. In the first half of 1954, after making allowance for a net investment abroad of £88 million, there was an improvement in the balance between assets and liabilities of £90 million. The gold and dollar reserve at £1,048 million in October was higher than at any time since 1950. Engineering exports have had much to contribute to this favourable situation. Including metals and vehicles they amounted to £113·5 million in the first three-quarters of 1954, an increase of 13 per cent.—or more than twice the average for all exports—over the same period in 1953. The trend is shown in Tables I and II and in the lower diagrams on the opposite page. Much of the increase was due to improved conditions in the Australasian markets, but it is significant that there were gains in the keenly competitive Western European markets, which offset a fairly considerable fall in exports to Canada. Surprisingly enough, the North American recession affected British exports to Canada, particularly cars, more than exports to the United States, which in the case of most engineering products actually increased.

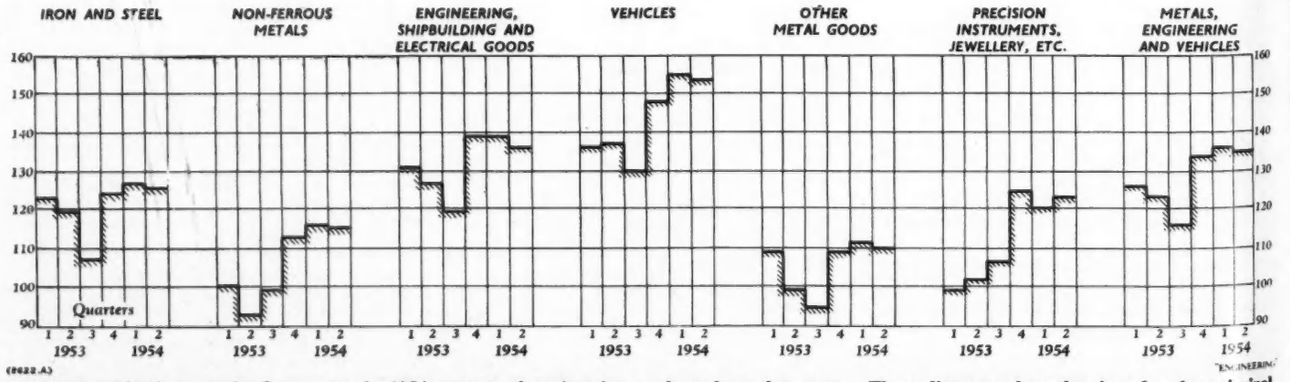
Although the outcome in 1954 was so eminently favourable, it is still necessary to inquire whether the achievement of British industry was really satisfactory—for achievement must be assessed in relation to the difficulties encountered—and whether the high prosperity in which 1955 begins is well founded. The increase in British industrial production does not compare particularly well with that in other European countries. In Germany and Italy, according to data compiled by the Economic Commission for Europe, output was 11 per cent. higher in the first half of 1954 than in the first half of 1953. The average for all Western Europe was 8 per cent., which compares with 7 per cent. for the United Kingdom. There was certainly no relative improvement in the British

TABLE I.—UNITED KINGDOM: VALUE OF EXPORTS OF METAL MANUFACTURES (£ MILLIONS)

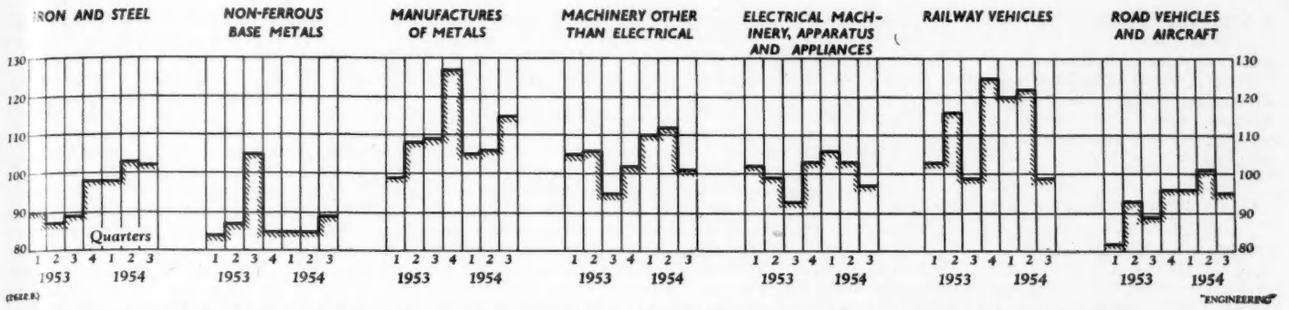
	1953		1954			
	1st half	2nd half	1st qr.	2nd qr.	3rd qr.	Oct.
Iron and steel	65·7	67·5	33·7	35·3	33·7	10·9
Non-ferrous base metals	30·3	30·4	13;7	13·9	14·1	4·4
Manufactures of metals	69·5	76·7	35·8	36·6	41·3	11·8
Machinery, other than Electric	201·0	196·0	106·3	105·7	99·3	30·9
Electric machinery, apparatus and appliances	87·4	84·9	45·4	43·0	41·0	12·6
Railway vehicles	20·4	22·1	11·8	12·4	10·4	3·3
Road vehicles and aircraft	144·5	146·0	77·5	81·9	76·0	22·9
Ships and boats	17·1	22·4	12·9	6·3	10·9	6·9

TABLE II.—UNITED KINGDOM: EXPORTS OF PRODUCTS OF THE ENGINEERING INDUSTRY TO SELECTED AREAS. (Monthly averages; × £1,000).

—	1953					1954 (January to September)				
	Machinery other than Electric	Electric Machinery Apparatus and Appliances	Railway Vehicles	Road Vehicles and Aircraft	Ships and Boats	Machinery other than Electric	Electric Machinery Apparatus and Appliances	Railway Vehicles	Road Vehicles and Aircraft	Ships and Boats
United States	1,012	198	1	1,545	4	1,332	236	—	1,625	5
Canada	1,797	715	232	1,469	97	1,603	609	182	892	73
Other American account countries	854	286	17	642	371	997	316	14	494	233
Non-dollar Western Hemisphere countries	1,005	292	249	637	127	685	280	134	358	51
Australia	3,304	1,423	535	2,811	35	4,059	1,459	448	3,882	50
Union of South Africa	2,570	1,652	387	1,313	11	2,459	1,525	792	1,307	91
Colonies	3,071	1,918	211	3,204	328	2,899	1,260	637	3,051	240
Non-sterling O.E.E.C. countries	8,798	2,388	257	5,802	1,136	8,914	2,637	237	6,596	1,634
O.E.E.C. possessions	788	136	46	508	6	650	127	75	535	11
Irish Republic and Iceland	983	296	58	575	2	1,165	284	100	948	123
Soviet Eastern Europe	164	306	43	31	—	165	273	7	21	—



Industrial production rose by 7 per cent. in 1954; output of engineering products by rather more. These diagrams show the rises for the principal categories as far as the latest figures for 1954 allow. The diagrams are based on an index of 100 for 1948.



Engineering made a significant contribution to the general increase of United Kingdom exports in 1954. Some of the principal increases are shown in these diagrams, where an index of 100 to represent the exports for 1950 is used as a datum. Probable trends in 1955 are discussed in this article, the first of a series which will review the main branches of the industry.

position in the second half of the year, for the rate of increase in industrial output has been slowing down. According to the Treasury *Bulletin for Industry* of December, the seasonally corrected index, which rose by nearly 2 per cent. from the first to the second quarter of 1954, rose by only 1 per cent. over the third quarter and did not rise at all in October. No unfavourable conclusions can of course be drawn from the fact that the increase in industrial production was less in the United Kingdom than in some other countries, for conditions are never exactly comparable; on the other hand, British prosperity is clearly not the result of an exceptional effort.

INVESTMENT IN PLANT

One of the principal objectives in British economic policy in 1954 was to stimulate home investment in plant and machinery. Gross domestic capital formation in the United Kingdom in 1952 accounted for only about one-eighth of the gross domestic products, compared with about one-fifth for the United States and over one-quarter for Western Germany. The greatly-accelerated housing output pushed the British gross capital formation up by 15 per cent. in 1953, but there was no increase in investment in plant and machinery. All the evidence suggests a rise of 4 per cent. in 1954. In some industries, notably motor vehicles, the steel and chemical industries, the increase must have been somewhat greater, but the level of investment in many sectors of British industry, including the engineering industry, is still disappointing. The full effects of the 1954 Budget will not, however, be felt until well into 1955, when the large volume of new industrial building projects approved by the Board of Trade begin to get under way. Certainly the large extension programmes announced by the motor vehicle and steel industries alone should mean significant increases in British investment in plant and machinery.

Whether the general level of investment will be satisfactory remains doubtful. Fortunately, the danger of under-investment has probably been exaggerated. In Germany, the urgent needs of reconstruction have necessitated an exceptionally high rate of investment. The large home market, for which mass production techniques are suitable, account for the high level of investment in the United States. In the United Kingdom, where manufacturers have to adapt their products to the diverse tastes of a large variety of markets, the scope for increasing the mechanical power behind each worker is very much less. An increase in the standard of living in the United Kingdom may depend as much upon raising technical skill and investing in technological education as much as upon increased investment in volume-production facilities.

The main yardstick for measuring British industrial achievement is sales performance in competition with other countries in the principal export markets. The comparison with foreign countries is not over-favourable for the United Kingdom. While British exports rose by 6 per cent. in 1954, German exports rose by 20 per cent. By the third quarter of 1954, German exports had risen to about 70 per cent. of the British compared with 61 per cent. in 1953. The increase in Japanese exports was about as large as the increase in German exports. On the other hand, the exports of the North American countries fell by about 6 per cent.

GERMAN COMPETITION

The large and continuing increase in the German share of world exports is not to be ascribed to superiority of German products. In some instances, however, something may be learned from German sales methods. German attention to detail in such matters as the presentation of trade literature, for example, is instructive, and the often greater intensity of their selling effort in some overseas markets where they may have twice as many representatives as their British competitors. The main reason for the relatively greater expansion of German exports lies simply in the nature of German exports and the more favourable conditions obtaining in the principal German markets. The extent of the expansion, moreover, is not exceptional when seen in longer-term perspective: whereas British exports per head of population are now about 48 per cent. higher than in 1938, Western German exports are only about 17 per cent. higher. The greatest proportionate gain made by German exports has been in chemicals. Exports of metals and engineering goods, which account for just over half the total (the same as in the United Kingdom), have expanded no more proportionately than British exports.

The composition of German exports of engineering goods, however, differs considerably from the British—for example, they include twice as many machine tools but only half as many tractors. Total German exports of non-electrical machinery have risen rapidly and are now almost as great as the corresponding British exports. German exports of metals and metal manufactures, on the other hand, have actually fallen, while the British have risen substantially. The increase in German exports of road vehicles in 1954, although proportionately more than the British, was the same in absolute terms, and the number of vehicles exported is still only half of the British total. The difference in distribution of British and German markets is striking: about half of the British exports go to the sterling area, while half of the German go to other Western European countries, whose total imports since 1950 have expanded by nearly 13 per cent. more than those of countries in the sterling area. One of the brightest signs in the outlook for British exports is that they are beginning to increase in Western Europe in pace with the German. The success of the British sales effort has been outstanding even in Germany, where British exports were up by about 17 per cent. in 1954.

The United Kingdom exports nearly three times as much to North America as Germany, and the recession there has consequently been more serious for British exporters. That British exports fell by 12 per cent. compared with only 4 per cent. for German exports is due to the greater emphasis in British exports to Canada on cars and durable consumer goods. The revival of economic activity should bring a considerable increase in British exports to Canada, where the market potential must grow rapidly with the development of the country's considerable natural resources. British enterprise is already heavily engaged in many of the development projects, including the St. Lawrence Seaway. Canadian imports from the United Kingdom are still only about one-seventh of the value of imports from the United States, but the proportion is increasing. Despite many advantages possessed by United States manufacturers, a wide range of British goods is competitive in Canada. Even in earth-moving equipment, British-made products have been gaining ground. One United States manufacturer, who also has manufacturing facilities in the United Kingdom, finds that his British-made products can be sold competitively in Canada with those made in the United States.

One of the weakest points in the British export drive is Central and South America. The market potential here is likely to grow rapidly in the next two decades. The population of the 20 Latin American Republics, which is now about 171 millions, is likely to increase to 275 millions by 1975, and income should grow more than proportionately. This change has not escaped the attention of United States exporters or of framers of United States economic policy whose object it has been to strengthen the economic ties between North and South America. The Germans have also been cultivating the South American markets assiduously and Germany has now supplanted the United Kingdom as their second largest supplier, smaller only than the United States.

In eight months of 1954, the Germans exported goods to the value of 248 million dols. compared with British exports of 151 million dols. Even so, British exports to Uruguay and Venezuela are larger than the German, and as may be seen from Table II the progress of British engineering exports, apart from vehicles, in the dollar-account Central and South American countries is very encouraging. The weakness in the non-dollar-account countries in present circumstances is not to be too grieviously deplored. The German success has been partly due to a policy of granting long-term overseas credits, which has put a heavy strain on the German economy. The banks have not always gladly supported Government policy, and large foreign credits are not likely to be granted so freely in future. Apart from the long-term Government sponsored credits, there are now few complaints from British exporters that their German competitors are gaining custom through being able to grant more liberal credit terms. German exporters have been known to complain that their own Ausfuhrkredit A/G is less flexible and accommodating than the London money market.

THE COMMONWEALTH

The prosperity of the United Kingdom still depends very much on the outlook for the sterling Commonwealth and Colonial markets. The fall in engineering exports to the Colonies—the result of the fall in Colonial income from exports of raw materials—was fairly considerable

in 1954, but the long-term outlook is sound. As was argued in special articles on "Engineering Goods in the Colonies" in our issues of December 3 and December 10, 1954, British engineering concerns may look forward to increased sales. The rate of increase may, however, be slow, since the pace at which investment can be undertaken in Colonial projects is limited.

AUSTRALIA'S POSITION UNCERTAIN

The market where future prospects are least predictable is perhaps Australia, the largest single market for British engineering products. Import restrictions there have been considerably relaxed in the past two years, and as may be seen from Table II, there was a considerable advance in British exports to Australia in 1954. Exports of vehicles rose by 36 per cent. and exports of machinery (other than electrical) by 20 per cent. Australia is, however, once more on the brink of an economic crisis. Wool prices in 1954 were about 15 per cent. lower than in 1953, and although the clip was somewhat larger, income from wool exports was down by nearly £60 million. The Minister of Trade, Senator O'Sullivan, has said that if prices do not recover in 1955 Australia may have to cut imports. The situation is aggravated by the high costs, including wages costs, in secondary industries, which in effect have to be supported by the hard-hit export industries. Past economic crises have been met by raising tariffs and otherwise restricting imports—a policy which has only increased the maladjustment in the costs of the secondary industries. Recognition is now growing in Australia that income cuts are no panacea for economic ills and a new crisis may well be met by devaluation, which would automatically cut real costs in the secondary industries and restore the export industries to a relatively favourable position.

The United Kingdom can, however, also do something to ease the difficulties—as the Australians have not been slow to point out. Although during the past few years there has been a large adverse balance with the United Kingdom, there has been an even larger surplus with the other principal wool-buying countries, Belgium, France, Italy and Japan. These countries, prevented by the Ottawa system of preferential tariffs from marketing their own goods in Australia, have been short of sterling and have consequently had to restrict their purchases of Australian exports. A large body of Australian opinion is thus naturally in favour of reducing or eliminating the tariff preferences. It is maintained that this will benefit the United Kingdom as well as Australia, since Australia cannot continue to import from the United Kingdom on the present scale if she cannot increase her export earnings.

Whereas the outlook in Australia is deteriorating, conditions are improving in South Africa where British engineering exports were down slightly in 1954. The South African Minister of Economic Affairs, Mr. Louw, announced in October that it was hoped to remove quota restrictions entirely in the not far distant future. A start was being made by increasing quotas for 1955. Among the products affected by the concessions are knocked-down motor vehicles for assembly in South Africa, and agricultural machinery. The preliminary quota for consumer goods will be 33 per cent. of imports in 1948 compared with 25 per cent. in 1954. Unfortunately, the reduction in quotas will probably bring an increase in tariffs; the South African Board of Trade has been receiving a growing number of applications for tariff assistance from industries which have prospered while imports have been restricted. Although the effect of tariffs on the cost structure in South Africa is appreciated, the need to avert the danger of unemployment in important sectors of industry may make an increase inevitable.

RUSSIA AND CHINA

Trade with the Soviet Bloc and China depends more upon political than economic factors, and is thus highly uncertain. Nevertheless, considerable progress towards better relationships were made in 1954. As a result of the revision of the embargo list in the autumn, British engineering exports to the Soviet Bloc should rise substantially in 1955. A large number of products are still prohibited, however, some of which can only be considered very indirectly as armaments potential. These include Diesel engines over 1,500 brake horse-power, generators of 10,000 kW and over, electric motors of 12,500 brake horse-power and electrical control gear. On the other hand, the relaxations cover such items as locomotives, general-purpose machine tools and chemical plant, for which there should be a useful market in Russia. Particularly interesting is the possibility of orders for ships: all available Soviet shipbuilding capacity is fully booked and useful orders might well be placed with Western yards. The export of ships is controlled, but trade agreements with Western European countries, including the United Kingdom, amount to at least 100 seagoing ships. For some sections of the engineering industry, including the textile machinery manufacturers, the possibility of trade with China may be of even keener interest than trade with Russia. Exploratory overtures made by trade delegations in 1954 have been highly successful, and important orders may well be placed in 1955.

Oddly enough, the Germans seem to be less interested in trade with the East than the British. There is a strong body of opinion in Germany which considers that the Russians are interested more in specimen imports which can be studied with a view to home manufacture than in volume imports. It is thought that, in any case, the Russian import potential is limited. Russian exports may not be capable of expansion, and the volume of imports which can be paid for in gold may be comparatively small. This seems an unduly pessimistic view. The United Kingdom alone imported goods to the value of £73·7 million from Russia in 1953. Since British exports amounted to only £28·8 million, there is obvious scope for a considerable increase in Russian purchases.

Despite the difficulties, the outlook for total engineering exports is on the whole somewhat better than in 1953, and if exports are maintained there is little danger of a fall in home sales. Order books for heavy plant are not, of course, so full as they were two or three years ago when rearmament reinforced the already heavy postwar replacement demand. The fact that they are now down to manageable proportions is an asset in world markets, since British firms can now in most cases compete on delivery with foreign competitors. Home demand for some types of plant and machinery is still somewhat disappointing, but the 1954 Budget provisions for increasing capital investment should begin to take full effect in 1955.

The second part of this general review of the engineering industry will appear in the issue of January 14. It will be followed by several articles on the main branches of the industry.

ADVANCES IN POWER ENGINEERING

EXPOSITION IN PHILADELPHIA

The engineers of the United States are well known for the speed with which they turn ideas into realities. The way they have accepted new ideas and turned them into practical production models was displayed at the 21st National Exposition of Power and Mechanical Engineering, held at the beginning of December in Philadelphia, Pa., U.S.A.

Nuclear power is of the first importance; the Atomic Energy Commission showed a model of their first nuclear power station, and the Westinghouse Electric Corporation had on their stand a schematic representation of the reactor-turbo-generator system that will feed power from it into the transmission lines of the Duquesne Light Company. Of more immediate interest to scientists and engineers was the first offering of a basic reactor designed for selective application in nuclear research. The exhibit showed a group of standardised components which could be assembled in various ways to serve stated purposes in research. It is the first time that industry, universities and research institutions have had a number of standard parts for reactors from which they can select those necessary to produce neutron and gamma rays, for isotope production, reactor technology, radio active materials and for biomedical studies.

As an example of advance in combustion engineering there was a model of the 1954 extension of the Jersey Central Power and Light Company's Raritan River plant, the largest steam generating unit in Eastern America to use cyclone furnaces. This unit is rated at 990,000 lb. of steam per hour at 2,050 lb. per square inch gauge and 1,050 deg. F.

BOILER UNITS

There were a large number of boiler units and boiler accessories at the Exposition. A packaged boiler unit has been developed that is completely self-contained, and requires neither special foundations nor stack. It is fully automatic in operation, with push-button start and stop, and is completely safeguarded. Oil or gas fuel is used, and where heavy oil is to be fired self-regulating preheaters are incorporated. In one two-pass boiler a "spinning gas" technique is used, whereby air is delivered to the burner through two rows of concentric air vanes which impart opposite spinning motion to the inner and outer shells of the air stream. At the opposite end of the fire box nickel-chrome impellers at the entrance of each tube whirl the returning flue gases to provide direct contact with the heating surfaces. Another boiler was of three-pass design ranging in capacity from 20 to 600 h.p.; one exhibitor had achieved a four-pass circulation of the hot gases by locating the furnace in the lower part of the shell.

An example of compact design and automatic operation was the "Watchman," developed to save idling costs on Diesel railway engines. The unit occupies a space 18 in. by 25 in. by 39 in., weighs 250 lb., and has a rating of 125,000 British thermal units per hour on 1·25 gallons of fuel, with an overall efficiency of more than 80 per cent. It circulates heated water through the Diesel-engine jackets at 10 gallons per minute; the engine is always ready to start without warming up, and need not be idled to prevent cooling off during lay-overs. In addition, when the engine would normally run cool on a light pull, the Watchman cuts in to boost the cylinder wall temperature and prevent excessive fuel consumption.

Among the boiler equipment on show was an internally-finned tube. This reverses the familiar application of extended radiation from the outside to the inside of the tube. In boilers it raises the fire-side to water-side ratio from 1·1 to 4·5. A special process for brazing the longitudinal fins inside the tubing had to be developed to produce these tubes. One item of steam equipment exhibited was a self-cleaning condenser. It incorporates a sluice gate arrangement which reverses the direction of flow, thereby flushing the debris from the inlet water box tube sheets and tube ends; much time can be saved by this device, because the cleaning can be done without pause in operation.

One firm had made a mechanical vacuum pump to remove air and non-condensible gases from surface condensers; this had been done because an increasing number of specifications demanded mechanical vacuum pumps rather

than steam air ejectors. The pump is a two-stage unit consisting of two single-stage rotary pumps of the sliding-vane type, with an inter-cooler mounted between. It is claimed to be the first unit of its type designed specifically for air injection.

For machine drives requiring frequent stopping and starting, as in textile plant, one exhibitor showed a "power transmitter." It consists of a totally enclosed and fully protected fan-cooled motor, having a high-inertia flywheel which runs constantly, and a driven end incorporating clutch and brake. The start-stop action may be manually operated, or worked by cam or screw from the driven machine.

AUTOMATION

Automation was the subject of an all-day conference of the Instrument Society of America during the Exposition, and formed a part of many of the displays. A large number of indicating and regulating appliances have been adapted to remote indication or control by transmission of pneumatic or hydraulic pressures, or by electric currents or impulses. Groups of such appliances are frequently assembled in control centres where conditions at scattered points may be observed simultaneously and corrections made as required in the interflow of processing events. The observations may be "reported" on separate dials or moving charts, or they may be combined into a single graph such as that of the scanner displayed by one exhibitor which may be extended to respond to signals from 20 different points, or 200. On one stand was a digital converter, the basic unit of which responds to a signal impulse by moving a printing wheel to a corresponding position. By association with other equipment it can add, multiply, or store data, feed into a computer, or actuate an electric typewriter.

Among the numerous exhibits of metals at the Exposition there were two newcomers. One represented the emergence of powder metals to the status of structural materials. The general method of production of the new steel "Oilite" is consolidation by sintering. The product has high ductility, high impact resistance and high fatigue strength. It is made in three grades with physical properties showing a range of 35,000 to 120,000 lb. per square inch ultimate strength; compressive strength 25,000 to 150,000 lb. per square inch; hardness 30 to 50 Rockwell B scale to 35 to 50 Rockwell C scale.

The second newcomer, also in the family of powder metals, is called a plastic steel, because it is composed of 20 per cent. cold setting resinous binder, 80 per cent. steel powder aggregate plus a special hardening agent. In paste form it can be moulded like putty, stiffening in one hour, hardening in two hours in air without shrinkage. In fluid form it can be cast and will permanently bond to wood, metal and glass; it can also be cast in waxed moulds. So formed it can be sawed, drilled, threaded or machined like steel. Its properties are: tensile strength, 10,000 lb. per square inch; impact, 0·7 to 0·8 ft. lb. per inch of notch, Izod; hardness 75 Rockwell F scale. It has already shown that it can make substantial economies when used for dies in light metal industries.

* * *

THREE MACHINE TOOL EXHIBITIONS

Chicago, September, 1955

Three concurrent exhibitions of interest to makers and users of machine tools are to be held in Chicago, U.S.A., from Tuesday, September 6, to Saturday, September 17, 1955. They are a Metalworking Machinery and Equipment Exhibition at the Coliseum; a Machine Tool Exhibition at the International Amphitheatre; and a Production Exhibition at the Navy Pier. Further details can be obtained from Exhibition and Convention Management Inc., 2689 East Overlook-road, Cleveland 6, Ohio.

OBERHASLI POWER SCHEMES

ELECTRICAL DEVELOPMENTS IN THE HASLITAL VALLEY, SWITZERLAND

The physical features of the Haslital, a narrow valley lying at the eastern end of the Bernese Oberland, make it one of the most favourable areas in Switzerland for the development of water power. The valley runs downwards in a north-westerly direction and the River Aare, which flows along it, gathers its waters from an area in which the geological structure consists largely of impervious rock, facilitating the construction of dams. There are a number of natural lakes and the tributaries of the river are fed from glaciers. The fall between the Grimsel Pass, at the head of the valley, and Innertkirchen at the lower end is about 1,200 metres. A map of the valley and surrounding district showing the hydro-electric developments with which this article is concerned is reproduced in Fig. 1, on this page.

A project to utilise the waters of the River Aare for power production was mooted more than fifty years ago in connection with a scheme to establish smelting works at Innertkirchen, but the concession was refused. Shortly afterwards, the Bernische Kraftwerke A.G. applied for a concession to utilise the river for general power production and this was granted in 1905, but it was not until 1925 that actual construction work was put in hand, the intervening 20 years being spent in detail surveys and commercial negotiations. These latter resulted in the formation of a subsidiary company, the Kraftwerke Oberhasli A.G., which proceeded with the development. (The district in which the Haslital is situated is known as the Oberhasli.)

The useful catchment area of the Oberhasli is about 200 sq. km. and the yearly run-off of the streams and rivers is approximately 403 million cub. m. About 90 per cent. of the total water available comes from precipitation in the area and, during the summer months, from the glaciers. The general situation is such that, by the construction of storage reservoirs, sufficient

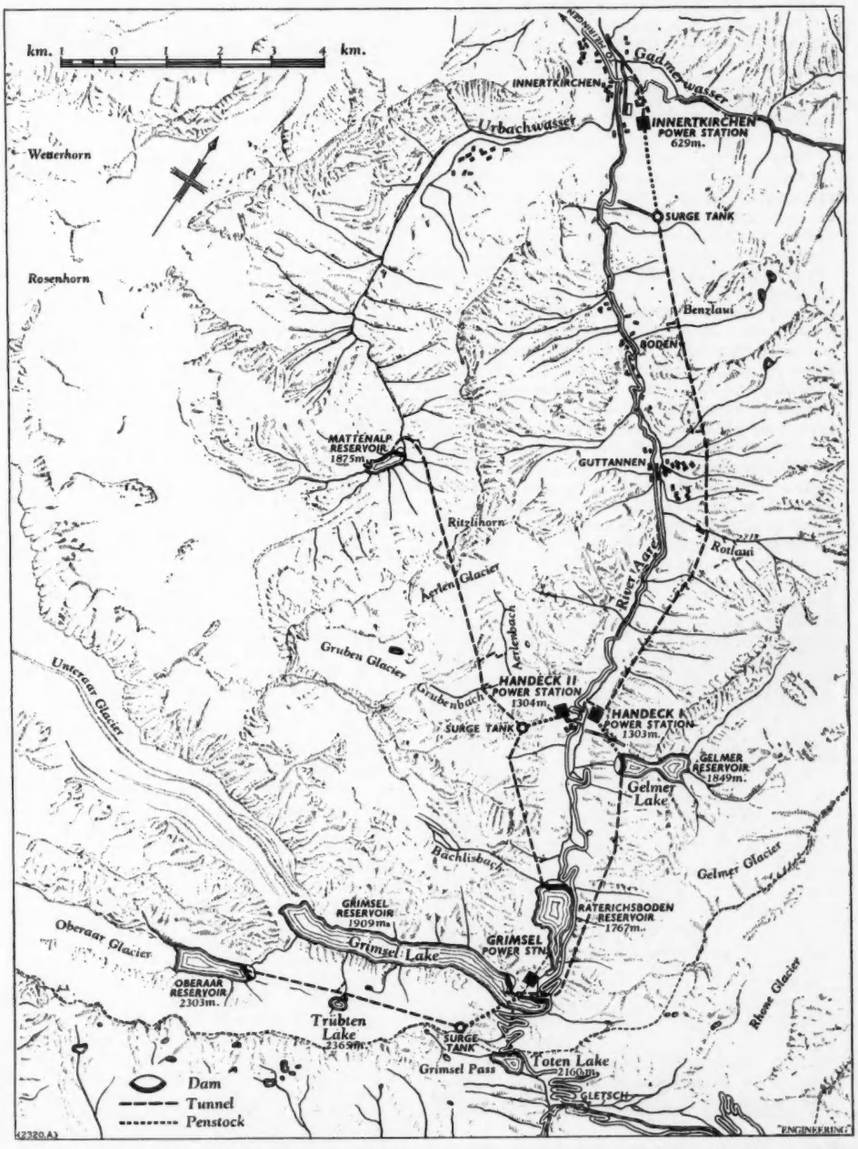


Fig. 1 Map of the Haslital valley showing the positions of the power stations and their connecting pipe-lines.

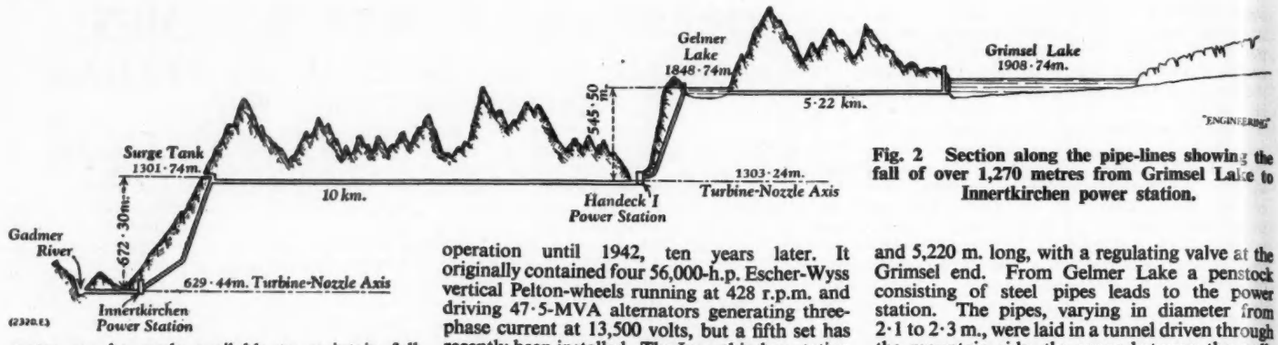


Fig. 2 Section along the pipe-lines showing the fall of over 1,270 metres from Grimsel Lake to Innertkirchen power station.

water can be made available to maintain full output in the winter months. Another advantage is that the water supply is fairly constant from year to year. The yearly potential energy available is of the order of 1,300 million kWh, of which a larger or smaller proportion may be made available in the winter depending on the extent of the storage provided. This is determined by economic rather than technical considerations.

FIRST DEVELOPMENT

The scheme first put in hand involved the building of two dams at the eastern end of Grimsel Lake and one at the western end of Gelmer Lake. These structures enabled the level of these lakes, and the outputs from them, to be controlled. The photograph reproduced in Fig. 3, shows the two dams at the eastern end of Grimsel Lake.

The scheme also covered the construction of two power stations, one, known as Handeck I, being situated in the valley to the west of Gelmer Lake and the other at Innertkirchen on the lower reaches of the river. A profile showing the arrangement of the connecting tunnels and penstocks is given in Fig. 2, above. It will be seen that water from Grimsel Lake is discharged into Gelmer Lake, the head at Handeck I power station being provided by the 545·5-m. fall from Gelmer Lake. As will be clear from the diagram the whole of the water passing through Handeck I station is utilised again at Innertkirchen station under a head of 672·3 m.

Handeck I station, which went into operation in 1932, contains four 30,000-h.p. Escher-Wyss vertical Pelton-wheel generating sets running at 500 r.p.m. driving 28-MVA Oerlikon three-phase alternators which generate at 11,000 volts, 50 cycles. Innertkirchen station did not go into operation until 1942, ten years later. It originally contained four 56,000-h.p. Escher-Wyss vertical Pelton-wheels running at 428 r.p.m. and driving 47·5-MVA alternators generating three-phase current at 13,500 volts, but a fifth set has recently been installed. The Innertkirchen station was designed from the first to utilise not only the discharge from Handeck I, but further supplies which would become available as other water sources in the Oberhasli area were developed. The cities of Basle, Berne and Zürich have each invested in the project and at the present time 50 per cent. of the capital is held by them. It was mentioned in our article on the electricity supply of the city of Zürich (ENGINEERING, vol. 176, page 129, 1953), that the total supply available from the stations in the Grisons Canton, owned by the city, had to be supplemented by supplies from other sources. Handeck I station and the compensating basin are shown in Fig. 4.

Fig. 3 The two dams on Grimsel Lake with the Nollen in between. Part of the main road is seen in the right foreground.

SECOND DEVELOPMENT

The more recent developments carried out by the company include the building of a power station, known as Handeck II, on the opposite side of the valley from Handeck I, and a further station immediately behind one of the Grimsel Lake dams, known as Grimsel station. The positions of both these stations and their connecting pipelines are indicated in Fig. 1. Handeck II went into operation in 1950, and the Grimsel station was completed and began generating in July, 1954. Handeck II contains two Escher-Wyss vertical Pelton-wheel sets running at 300 r.p.m. with outputs varying from 32,700 h.p. to 42,300 h.p., depending on the head available. Provision has been made for two more. The Oerlikon alternators are rated at 40 MVA and generate at 13,500 volts. The Grimsel station contains a single horizontal two-wheel Pelton set with a total capacity of 42,000 h.p., and, in addition, a storage-pump unit with a capacity of 4 cub. m. per second against a head of 400 m. The generating unit will operate only in winter months and the pumping set only in summer, when it will draw water from Grimsel Lake and deliver it to the Oberaar storage reservoir, the position of which is shown in the lower left-hand corner of Fig. 1.

The Handeck II station taps water sources additional to those furnished by the Grimsel and Gelmer Lakes. The most important of these is the Räterichsboden reservoir formed by building a dam across the valley. From it, a tunnel connects, at a point west of Handeck II, with a tunnel carrying water from the Mattenalp reservoir formed by building a dam on the headwater of the stream known as the Urbachwasser, which joins the River Aare at Innertkirchen. Three other sources have also been tapped. The largest of these, the Oberaar Reservoir, will supply the Grimsel station through a tunnel to which a connection from the small Lake Trübten has been made. The discharge from Grimsel station will pass into the Räterichsboden reservoir and augment the supply to Handeck II. Supply from the third source, Lake Toten, passes directly into Grimsel Lake.

As will be gathered from Fig. 2, Gelmer Lake acts as a regulating reservoir for the output from Grimsel Lake and controls the head at Handeck I power station. It, however, is also fed by glacial water and adds something to the total supply available. Grimsel Lake has a usable capacity of 100 million cub. m. and Gelmer Lake one of 13 million. The two lakes are connected by a tunnel 2·6 m. in diameter and 5,220 m. long, with a regulating valve at the Grimsel end. From Gelmer Lake a penstock consisting of steel pipes leads to the power station. The pipes, varying in diameter from 2·1 to 2·3 m., were laid in a tunnel driven through the mountain side, the space between the walls of the tunnel and the pipes being filled in with concrete. The fall between the lake and the power station is 545·5 m.

The discharge water from Handeck I passes to a tunnel 10 km. long and 3·3 to 3·4 m. in diameter which supplies Innertkirchen power station. There is a surge tank at about 2 km. from the station, as shown in Fig. 1. The tunnel and station were designed from the first to deal with a greater water supply than that furnished by the discharge from Handeck I, and the tail race from the new Handeck II station discharges to this same tunnel at a point west of Handeck I.

Although the building of the Grimsel and Gelmer dams was put in hand as long ago as 1925, brief reference may be made to them. Of the two Grimsel dams, the more easterly, shown in the foreground of Fig. 3, and called the Seeuferegg dam, is a straight gravity structure 32 m. high, containing 70,000 cub. m. of concrete. It carries the road leading to the Grimsel Hospiz which stands on the Nollen hillock separating the two dams. The Hospiz road connects with the Innertkirchen road which runs down the Haslital; part of it can be seen below the dam in Fig. 3. The second dam, the Spitallamm, is a curved gravity structure 258 m. long on the crest and with a height of 114 m. above the lowest point of the foundations. It is 64 m. thick at the foot tapering to 4 m. wide at the top, and contains 340,000 cub. m. of concrete. The 2·6-m. diameter tunnel connecting with Gelmer Lake is driven through the Nollen. The Gelmer dam is a straight gravity structure 35 m. high. In an underground chamber, 134 m. below the Hospiz, is an instrument and control post. As it is necessary to regulate the flow at all seasons of the year, accommodation is provided in the Hospiz for the attendants. The total capacity of the four power stations when all are in full operation will be approximately 578·25 MVA.

HANDECK I POWER STATION

As Handeck I station has been in operation since 1932, it will not be described here in detail.

Fig. 4 Handeck I power station showing the living quarters on the right and the compensating basin in the foreground.

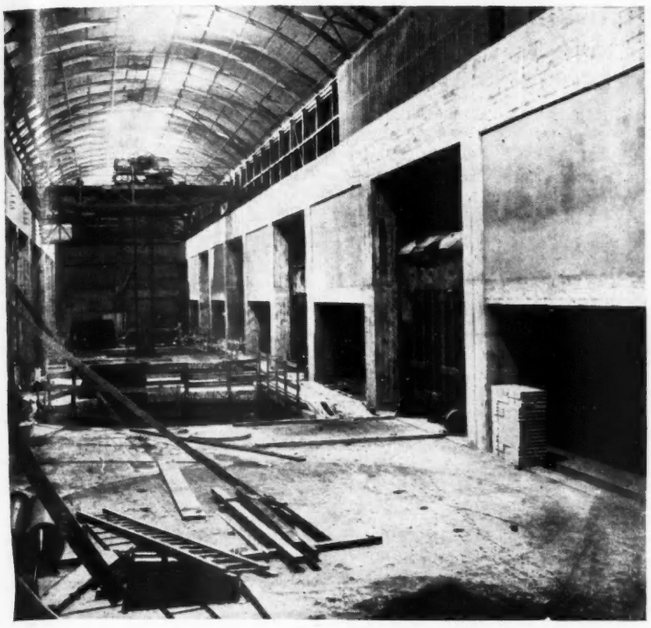


Fig. 5 Innertkirchen was the first underground power station built in Switzerland. The transformer chambers are on the right.

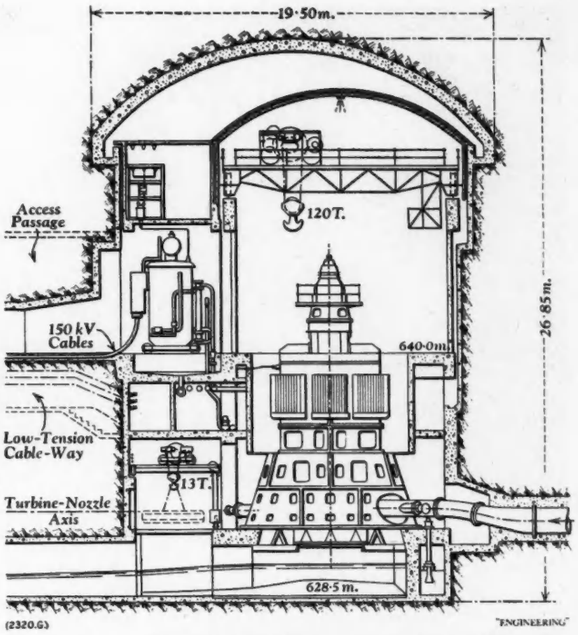


Fig. 6 Cross-section of Innertkirchen power station; there is at least 40 m. of rock above the ceiling. Access is by a tunnel 40 m. long.

The general lay-out is not greatly different from that of Handeck II which will be dealt with later in this article; as a matter of interest it may be mentioned, however, that both these stations are almost isolated in the winter season, snow avalanches in the valley below making access dangerous. For this reason attendant staffs are accommodated in nearby dwellings so situated as to be safe from avalanches. Isolation, is however, not complete as a tunnel, provided with a battery-driven rail car, connects the stations with the village of Guttannen, situated about 3·7 miles down the valley. The transmission cables are also laid in this tunnel. Handeck I power station, with the staff headquarters is illustrated in Fig. 4.

INNERTKIRCHEN POWER STATION

Although the Innertkirchen station has been in operation since 1942, it is of particular interest as it was the first underground station to be constructed in Switzerland, and as it contains examples of the largest generating sets in the country. As will be clear from the map, Fig. 1, Innertkirchen is in a sense the key station of the whole Oberhasli development. It receives and utilises the whole of the water discharged from the other stations higher up the valley. In December, 1952, it was decided to increase the supply to, and the capacity of, the Innertkirchen station by diverting the river known as the Gadmerwasser and utilising its water for power generation. When the work is completed the total capacity of the Oberhasli development will be 1,300 million kWh per annum.

Although it is clear that the case for an underground station must be determined by the features of the site, it is stated that, when these are favourable to excavation, a power house in rock may be from 10 to 30 per cent. less costly than one above ground. Also maintenance costs are lower and immunity from aerial bombardment is ensured. A general view of the generator room, during construction, is given in Fig. 5, on this page. The station is situated in the mountain slope on the east side of the valley and the inlet tunnel, penstock tunnel and tail race were all excavated in the solid rock.

The underground chamber forming Innertkirchen station is 100 m. long, 19·5 m. wide and 26 m. high. Access to it is obtained through an excavated passage-way 40 m. long. The thickness of the overlying rock is nowhere less than 40 m. and no reinforcement was necessary. Inner walls and a false ceiling separate the interior of the station from the excavated rock surface so that any seepage may be drained away without entering the machine rooms. The main machine room is shown in Fig. 7 and a cross-section of the station in Fig. 6. The generators are mounted directly on the turbine housings so that the entire weight is taken by the underlying rock foundation. The operating floor is carried on a steel structure and the transformers stand in recesses between the generators. The floors which carry the transformers are shaped in the form of trays so that any oil is caught. Pipes lead to an oil sump large enough to hold the whole of the oil from the transformers.

The Escher-Wyss turbines have a rated output of 56,000 h.p. at a speed of 428 r.p.m. The working head is 650 m. and the water consumption 7·5 cub. m. per second. They are of the vertical Pelton-wheel type with wheels having an outside diameter of 2,924 mm. and a pitch circle of 2,300 mm. Each is served by two nozzles. Connection from the valve chambers is through a 1,200-mm. diameter pipe ending in a V branch.

The diameter of the jet is 208 mm. and the velocity of the issuing water approximately 110 m. per second. Regulation is effected both by adjustment of the needle valve and by deflection of the jet. The position of the needle is controlled by oil pressure acting on a piston. The deflection is operated by oil pressure for increasing the speed and by water pressure for reducing it so that the turbine can be shut down in the case of failure of the pressure-oil system. The governor controlling the turbine is situated on the operating floor; it consists of a central valve controlling the pressure oil and a servomotor operating the deflectors. The mechanism is actuated by a pendulum governor supplied from a generator on the main alternator shaft. Regulation is automatic, but the governor can be controlled from the station-operating switchboard. The arrangement embodies an emergency cut-out.

Below each turbine there is a discharge pit connected to the tail-race channel by a short tunnel; the channel is equipped with flow-registering apparatus. With this arrangement, it is necessary to shut down all other turbines if the discharge from any one is to be measured. The tail race leads to a tunnel 1,295 m. long discharging to the Gadmerwasser. As the bed of the tunnel is below the lowest level of the river, a terminal gate and a pump installation are provided so that the tunnel may be pumped dry for maintenance and inspection.

The Oërlikon alternators each have a rated output of 47·5 MVA when generating at 13·5 kV. It is intended later to raise the voltage by 10 per cent. to 14·85 kV increasing the rated output to 52·25 MVA. The operating speed is 428 r.p.m. and the runaway speed 790 r.p.m. The frequency is 50 cycles. The machines are air cooled, circulating air being drawn partly from the generator pit, which is 8 m. in diameter, and partly from outside the station through ducts; air coolers consisting of nests of pipes, through which water from the turbine pit is circulated, are mounted on the alternator casings.

The weight of the rotating parts, including the turbine wheel, is about 140 tons. This is carried by a thrust bearing mounted in a steel structure on the alternator casing. The shaft, having an overall length of 12 m., is divided into

Fig. 7 Inner walls and a false ceiling prevent any seepage of moisture into the machine room.

Fig. 8 Approximately square-section tunnels were first driven through rock, the spoil being removed by trucks. Then the tunnels were made circular by drilling from a travelling carriage. The flat trucks shown here are used for transporting cables.

three sections to facilitate assembly, the station not being sufficiently high to permit the handling of the whole shaft. The transformers are each rated at 47·5 MVA. They step up the 13·5-kV supply from the alternators to 150 kV, and are cooled by oil circulation, the oil passing through water coolers. The high-tension terminals are of the oil-filled type and there is no bare 150-kV metal in the station. Connection is made to the outdoor substation by three oil-filled cables, a fourth spare cable being provided for emergencies.

TUNNELLING

The Oberhasli development has involved the driving of a number of tunnels for the supply to, and discharge from, the various power stations. Typical of them is the main feeder tunnel to Innertkirchen station. It is 3·3 to 3·4 m. in diameter and from the discharge point of Handeck I to the surge tank at the head of the penstock is 10 km long, as shown in Fig. 2, page 14. It was driven through granite and gneiss except for a short section at the penstock end where some sedimentary rock was encountered. A tunnel of approximately square section was first excavated; in this a concrete floor was formed on which rails were laid which carried trucks for the removal of rubble and debris. A view taken from one of the adits is given in Fig. 8. The tunnel was subsequently enlarged to its circular section by drilling from a travelling carriage.

Four types of lining were employed depending on the nature of the strata encountered. At the Handeck end, for the first 3,600 m., where the formation was solid rock, the tunnel was provided with a 10-cm. thick concrete lining with a coating of cement applied to protect the concrete from the action of water with a lime content. This part of the tunnel was 3·4 m. in diameter. The second type of lining consists of lightly-armoured concrete liner plates 4 cm. thick, impregnated with bitumen under pressure and at a temperature of 120 deg. C. The plates are supported by steel rings 100 cm. apart and the space between the plates and the rock was filled with grout applied under pressure and vibrated. The gaps between the steel rings were sealed with liquid bitumen. A length of 5,400 m. of the tunnel, passing through rock less compact than the granite of the first section, was provided with this type of lining. The third type consists of a reinforced-concrete gunite lining used in a section 430 m. long which was not impervious to water. The fourth type was used for a section immediately adjacent to the surge chamber and connecting to the penstock. It consists of steel pipes backed by concrete filling.

The surge pipe at the lower end of the tunnel embodies an inclined shaft, 3·1 m. in diameter, forming a continuation of the penstock, and a vertical shaft 8·5 m. in diameter and 59·3 m. long, rising from the feeder tunnel. The two shafts connect to a water chamber 24 m. long, 13 m. wide and 10·5 m. high. There is a throttle valve at the junction of the feeder tunnel and the vertical shaft. As a result of this arrangement the movement of the water level in the vertical shaft lags behind that in the inclined shaft, the difference possibly being as much as 25 m. This arrangement damps any oscillations in the water level at the head of the penstock. The throttle valve is connected to the controlling mechanism in a valve house above the water chamber by a vertical spindle 60-m. long. The mechanism is operated by remote control from the power station.

The penstock is lined with steel pipes throughout, and has a total length of 1,911 m. The upper section, 1,094 m. long, has an internal diameter of 2·6 m. and is inclined at an angle of 60 per cent., while the lower, 2·4 m. in diameter and 817 m. long, is inclined at an angle of 12·3 per cent. The pipe walls vary from 12 mm. to 20 mm. thick. The maximum water discharge through the penstock is 36 cub. m. per second. The tunnel in which the pipes were laid was excavated in granite, through three adits and also from the power-station end. It was constructed with a concrete floor carrying rails and the sections of pipe were introduced at the top end and slid down into position on these rails. This operation is illustrated in Fig. 9, on this page. A carriage mounted on wheels was clamped to the front ends of the section as shown in this illustration; the rear ends were provided with sliding shoes. A conduit was formed below the rails through which concrete was introduced to fill the space between the outside of the pipe and the tunnel wall, final good contact being ensured by grout injection.

The penstock terminates in a distributing pipe, with a wall thickness of 24 mm., which is stepped-down in diameter as the various branches are taken off. It is surrounded by an outer pipe in the manner shown in Fig. 10. The space between the two pipes, and also that between the outer pipe and the tunnel wall, was built-in with concrete slabs and the whole was filled with concrete under pressure, forming a solid monolithic structure. The branch pipes have a wall thickness of 46 mm. and are embedded in solid concrete. They lead to an underground valve chamber which is entirely separate from the power station, so that in the possible event of the bursting of a valve casing the power house is not endangered.

There are two valves on each distributing pipe. The first is an emergency valve, closed only for inspection and maintenance or in case of breakdown, and the second is the control valve proper. Both valves are of the rotary type, hydraulically-operated and remote-controlled from the power station desk. The first valve, 1,100 mm. in diameter, is directly connected to a Venturi meter for measuring the consumption of the connected turbine. Tests have shown that in the event of the breakdown of a pipe the valve can be closed in 70 seconds without causing serious vibration.

To be continued

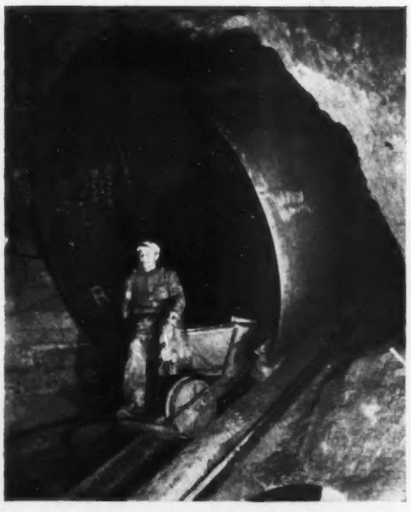


Fig. 9 Sections of the steel penstock pipe were lowered into position on wheels and skids, and the surrounding space filled by grout injection.

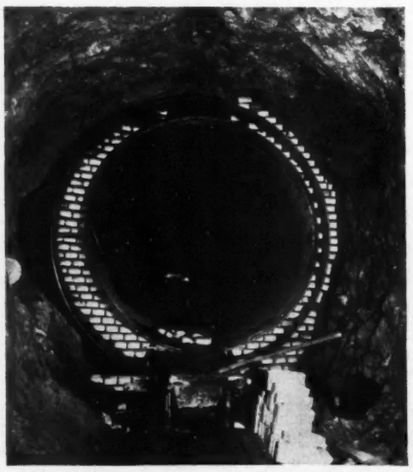


Fig. 10 The distributing pipe is surrounded by an outer pipe, the intervening spaces being packed with concrete slabs and then filled with concrete under pressure.

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STEEL DERRICK POLE

Substitute for Timber

An all-steel derrick pole, built up from standard-length box-section units which are bolted together to give the required height, is now being made and marketed by John Booth and Sons (Bolton), Limited, Hulton Steelworks, Bolton. Due to the difficulty of obtaining suitable timber poles for the firm's own outside steel erectors, they originally designed the pole solely for their own use.

The sections of the pole, available in two lengths of 14 ft. and 6 ft., are fabricated by welding pressed-steel plates to form a box section having rectangular openings with well-rounded corners on all four sides; these holes allow the pole to be climbed easily to attend to the rope gear. All the bolt holes for cover plates, brackets, fittings and splices are jig drilled. The units are galvanised after manufacture. The base unit has a wooden block set in the bottom end to prevent slipping and the top unit is fitted with a bracket for a cat-head or lifting point.

METERING PULSATING FLOW

COEFFICIENTS FOR SHARP-EDGED ORIFICES

By J. M. Zarek, PH.D., B.SC., A.M.I.MECH.E.*

The investigation on pulsating air flow described here, which was limited to the incompressible range of flow and low-frequency pulsations, shows that under pulsating flow a U-tube manometer, either damped or undamped, indicates the mean differential pressure across the orifice, but that the coefficient of discharge as defined for steady-flow conditions is no longer applicable. A preliminary attempt to determine a correction factor to the steady-flow coefficient of discharge which would allow for the effect of pulsations in the form of a non-dimensional number derived from a large number of experimental results is given to illustrate the approach to the solution of a problem generally recognised as being complex.

The method of measuring steady flow by observing the pressure drop across a throttling device, such as an orifice, nozzle, or venturi tube, is well established. If, however, the flow is of a pulsating nature—and in practice there are very few cases where the flow is steady—a serious error in the results may be present.

The effect of pulsations on the error of measurement of flow has been investigated by many workers. The sharp-edged orifice has received most attention, and is used in the present investigation. Study of published work shows that various mathematical methods have been advanced for calculating the square-root error[1] arising from pulsations but they have proved to be of little practical value.

With the exception of H. Judd and D. B. Pheley,[2] who built special apparatus, most experimental work has been carried out on actual plants which limited the scope of the work. It is clear from their investigations that the error is serious and that its nature is complicated; the conclusion was reached that the only solution was to eliminate pulsations. Thus the British Standards Institution states "In all cases where the pipeline to be metered carries a flow which is pulsating due to reciprocating engines, pumps, blowers, or compressors, it is essential that sufficient circuit damping exists to reduce the flow wave form to a suitable extent."

In view of the incomplete state of the available knowledge on the subject of metering pulsating flow, it was decided to make a new attempt to understand the problem. An experimental investigation was necessary to serve as a basis for an analysis capable of application to any kind of pulsating flow. The experimental work described here forms an interim report. It was carried out with equipment which limited the frequency to a relatively small range, and although a simple method of measuring pressure amplitudes was used the results have been confirmed using a cathode-ray oscillograph.

PULSATION AMPLITUDE MEASURED OPTICALLY

Fig. 1 shows diagrammatically the apparatus used to superimpose on a steady flow the required pulsations while leaving unchanged the quantity of air flowing. Air was supplied by a rotary blower fitted with a throttling valve on the inlet side to control the flow. On the delivery side, two large air tanks were installed between the blower and the metering orifice. To produce the pulsations, a cylinder with a reciprocating piston driven by an electric motor through a crank and connecting rod was attached to the pipe near the metering orifice and, as desired, either upstream or downstream of it. The stroke of the piston could be varied so that the amplitude of the pressure wave caused by the displacement of the piston lay within a convenient range. Any desirable frequency of the pulsations was obtained by adjusting the speed of the motor. Frequencies from 0-200 pulsations per minute were used, corresponding to large and slow-running reciprocating compressors and engines.

The amplitude of the pressure wave was measured by an optical indicator in which the pressure acted on a rubber membrane; the indicator was connected by a short pipe with the upstream or downstream sides of the orifice. The centre of the vibrating membrane when deflected gave, by means of a single lever, a rotary movement to a small mirror which reflected the ray from a concentrated source of light on a ground-glass screen. Static calibration of the indicator was possible, and, since the lever was very light, the inertia effect was considered to be small within the range of frequencies employed.

The pipe used was 2 in. in diameter, and the sharp-edged orifices tested gave the following six ratios of orifice diameter to pipe diameter: 0·25, 0·375, 0·5, 0·625, 0·75, 0·875.

For measuring the pressure differences, U-tube manometers were used, one installed at the metering orifice, one along the pipe and one at the capacity tank.

In each test initial readings were taken after steady conditions of flow had been obtained; the pulsator was then put into operation and maintained at the required frequency, and the readings under pulsating conditions were then taken, the volumetric rate of flow remaining practically unchanged.

PRESSURE DROP, PULSATION FREQUENCY AND AMPLITUDE VARIED

The steady-flow reading was adopted as the basis for analysing the magnitude of the error brought about by the pulsations superimposed on it. This arrangement, in addition to making it possible to investigate the effect of the ratio of orifice to pipe diameter, magnitude of the pressure drop across the orifice, frequency of pulsations and amplitude of pressure wave, was expected to give information as to whether the discharge through the orifice as determined by the steady-flow formula is affected by pulsations. This is important, as it is a common belief that the effect of the pressure variations is largely responsible for the error of measurement only, whereas the change of flow, if any, is very small and may be neglected.

In all the tests air was used at a temperature of 19 deg. to 21 deg. C. Although the density and viscosity of the measured gas may influence the results, these effects have not been studied as yet. The tests were carried out for all the orifices over the range of pressure drops up to 10 in. of water, by steps, through the range of frequencies from 0-200 pulsations per minute, with the pulsator placed both upstream and downstream of the metering orifice. The diameter of the pulsator was 8 in., and to obtain a variation in the value of the amplitude four lengths of stroke of the pulsator (9 in., 6 in., 4·75 in. and 3·5 in.) were employed.

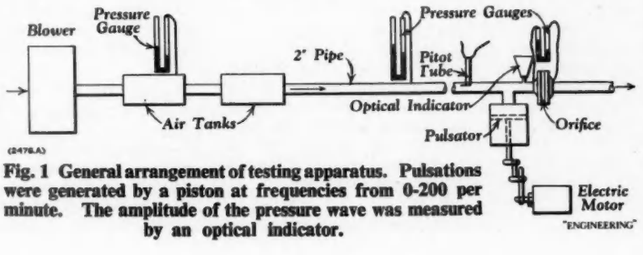

Fig. 1 General arrangement of testing apparatus. Pulsations were generated by a piston at frequencies from 0-200 per minute. The amplitude of the pressure wave was measured by an optical indicator.

STEADY-FLOW RELATION NOT VALID

Recent investigations have assumed that the steady-flow formula relationship between mass flow and pressure drop holds good and that the error is due to the peculiar behaviour of the manometer under pulsating-flow conditions. The assumption has been that the orifice will measure correctly if the pressure-differential indicating device gives accurately the instantaneous pressure drops across the orifice, since the flow may then be calculated as a summation of instantaneous steady flows. The experimental results of the present investigation, however, suggest that if the coefficient of discharge as determined for steady flow is used, incorrect results are obtained.

The readings from the pressure gauge located at the capacity tank showed that, when pulsations at the orifice were superimposed, the pressure-head readings in the tank were changing at approximately the same rate as the pressure drop across the orifice, although the pulsations in the tank were practically smoothed out.

There is still some uncertainty as to what the U-tube indicates when measuring pulsating flow. Therefore conclusions on the behaviour of the orifice under pulsations could only be drawn if the tank were free of any pressure fluctuations and the U-tube readings were not affected by pulsations, or the behaviour of the U-tube under those conditions were known. Firstly, therefore, the pulsations in the tank were reduced to an even smaller value by inserting an additional orifice between the metering orifice and the capacity tank. Tests have shown that in spite of practically complete absence of pulsations in the tank a similar change in the static head has been recorded.

Secondly, when comparing the mean pressure differential indicated by the manometer with the corresponding value indicated by the optical indicator, it was found that the two values were practically identical. This led to a further investigation of the behaviour of the U-tube, using a cathode-ray oscillograph with suitable pick-ups and a camera recording the shape of the differential pressure wave.

MEASURING THE MEAN ORIFICE PRESSURE DROP

Fig. 2, on page 18, shows recordings of the variation of the pressure drop across the orifice. Tests on various shapes of waves show that the U-tube manometer, damped or undamped, indicates the mean of the pulsating pressure drop across the orifice, but when compared with the differential pressure at steady conditions its value for the same mass flow in most cases was different. Therefore, since the mass flow with pulsations was practically the same as for steady flow but to effect discharge another pressure drop was required, the discharge formula for steady flow requires to be examined. Allowing for the square-root error, the experimental results indicate that erroneous values for the flow would still be obtained and that the coefficient of discharge for the orifice, as defined for steady conditions, does not apply to pulsating flow.

It is assumed here that the coefficient of discharge for steady flow is well defined, and, therefore, all that is necessary is to apply a correction factor which will compensate for the effect of pulsations. For each test, the square root of the ratio of the steady-flow pressure drop to the mean pressure drop under pulsating flow was evaluated to give the correction factor for the test by which the coefficient of discharge for steady flow should be multiplied to give, in the steady-flow formula, the correct relation between the mass flow and the mean differential pressure drop across the orifice.

Figs. 3 to 7, on page 19, illustrate the results from which the following observations were made. The coefficient of discharge for pulsating flow

* Lecturer in Mechanical Engineering, King's College, University of London.

—	Record					
	a	*b*	*c*	*d*	*e*	*f*
Pulsations per min.	50	100	150	200	300	400
Line A denotes pressure drop in inches of water at steady flow ..	1·53	1·53	0·98	0·98	1·78	1·82
Line B denotes pressure drop in inches of water as read by U-tube manometer	1·51	1·53	1·18	1·43	2·38	2·62
Error, per cent. ..	1·8	0·7	1·8	0·8	0·4	0·0

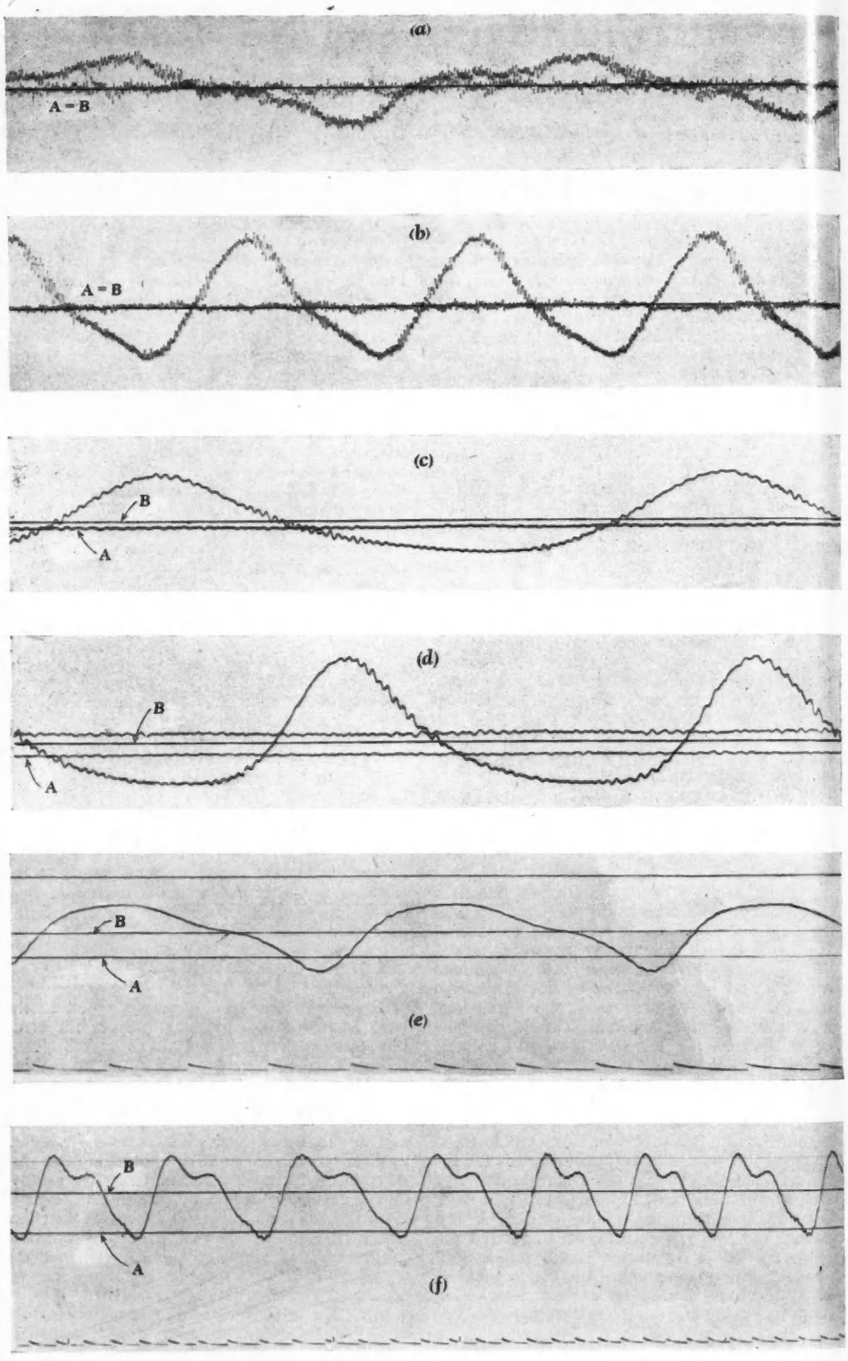

Fig. 2 Typical cathode-ray oscillograph records of the pressure drop across the orifice compared with the corresponding U-tube readings are shown on the right and the values are given in the table above.

decreases: (*a*) with the decrease of pressure drop across the orifice; (*b*) with the increase of the amplitude of the pressure wave; (*c*) with the increase of pulsation frequency; and (*d*) with the decrease of orifice to pipe diameter ratio when the mean pressure drop across the orifice is maintained constant for all orifices.

In tests with the pulsator placed upstream the new coefficient of discharge was always found to be smaller than that for steady flow, but with the pulsator in the downstream position several results indicated that it was greater. However, in view of the very limited number of those results no explanation is offered.

It has been shown that the U-tube indicates the mean pressure drop across the orifice and that its value may differ largely from the required pressure drop under steady conditions for the same mass flow. The deviation may be so great that allowance for the square-root error will not give the required steady-flow formula relationship between the mass flow and pressure drop across the orifice. It therefore must be concluded that the orifice when measuring pulsating flow does not behave in the same way as interpreted by the steady-flow formula. After all, the coefficient of discharge for steady flow was defined experimentally, as even for that type of flow it would be difficult to predict analytically the correct laws for the changes of energy occurring at the orifice. There is no valid reason to assume, in the case of pulsating flow, that the same coefficient of discharge should still give the same relationship between the differential pressure and the mass flow. It should be the object of extensive experimental work to supply sufficient data for establishing coefficients of discharge, perhaps in terms of some dimensionless parameters describing the nature of the metered pulsating flow.

DYNAMIC EFFECTS OF PULSATING FLOW

In pulsating flow, as well as pressure variations there also take place velocity variations, during which the particles of the flowing medium are accelerated and retarded. As the manometer under pulsating-flow conditions measures the mean differential pressure, and as this is usually different from the one recorded under steady conditions for the same mass flow, it is inferred that a dynamic effect manifests itself in the pulsating efflux of the jet, and changes the discharging characteristics of the orifice.

In the case of a very slow rate of pulsation, the flow pressure and velocity wavelengths are great and, therefore, since the flow pattern is similar to that under steady conditions, no significant change in the coefficient of discharge may be observed. With increasing frequency of pulsation the wavelengths decrease, and a dynamic effect on the discharge coefficient begins to appear as particles in the outcoming jet travelling with different velocity have on each other a greater accelerating or retarding effect. The magnitude of this effect, it is assumed here, depends mainly upon the length of the emerging jet from the orifice, through which the particle of gas has to pass, and upon the length and amplitude of the flow velocity wave.

The analysis of the results of this investigation demonstrates that it is difficult as yet to assess quantitatively the effect of the considered variables on the coefficient of discharge separately. A reasonable degree of accuracy in the measurement of pulsating flow should, however, be possible by expressing the correction factor in terms of quantities which are characteristic of pulsating flow. Several combinations of the variables recorded were investigated, and it was found that, with the data available, the best results were obtained when the variation of the correction factor was expressed as a function of the following non-dimensional number

$$\frac{L\,\Delta P}{A\,d}$$

where L is the ratio of the velocity of the emerging jet (as found from the steady-flow formula) to the frequency, and referred to as the " flow-velocity wavelength "; d is the orifice diameter; A is the amplitude of the pressure wave measured near the orifice cross-section in the region where the source of pulsations is placed; and ΔP is the pressure drop across the orifice as measured under pulsating conditions of flow.

From Fig. 8 it is seen that the smaller the non-dimensional number the greater is the correction. The points are more scattered in the range of small values of the non-dimensional number, but as these values represent the range of small pressure drops across the orifice, it may be assumed that the increased degree of scatter is due to the effect of the experimental

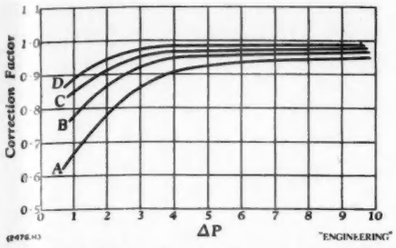

Fig. 3 Variation of the mean value of the correction factor for the tested range of frequency with pressure drop ΔP (inches of water) for various strokes of the pulsator. Orifice diameter 1·25 in., $\frac{d}{D} = 0{\cdot}625$.

A .. curve for amplitude induced by 9-in. stroke.
B .. " " " 6-in. "
C .. " " " 4½-in. "
D .. " " " 3¼-in. "

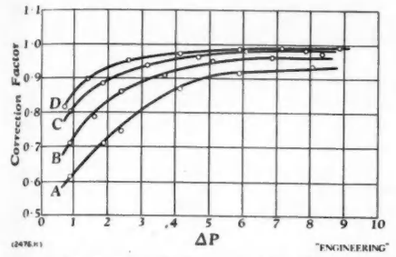

Fig. 6 Variation of the correction factor with pressure drop across the orifice for various strokes of the pulsator at constant frequency (approximately 90 pulsations per minute). Orifice diameter 1·25 in., pulsations applied upstream.

A .. curve for amplitude induced by 9-in. stroke.
B .. " " " 6-in. "
C .. " " " 4½-in. "
D .. " " " 3¼-in. "

error on the accuracy of the calculated results increasing with the decrease of the pressure drop.

Although the experimental results cover only the range of slow-running large-piston compressors and engines, it may be expected that with an increase of pulsation frequency there should be a consistent decrease in the value of the correction factor. It is not, however, concluded that the linear relationship between the correction factor and frequency as assumed for the tested range will hold good in the higher range of frequencies.

In applying the non-dimensional number to a practical case, all the component values can be determined with the exception of the flow-velocity wavelength at the orifice, as the true velocity of the emerging jet is not known. In the evaluation of the correction factor, therefore, a method of consecutive corrections has to be used. When, for instance, the amplitude of the

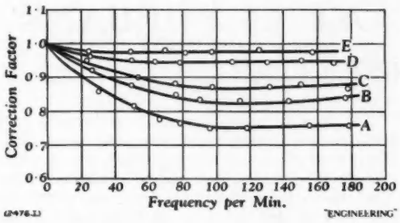

Fig. 4 Variation of the correction factor with frequency for various pressure drops across the orifice. Orifice diameter 1·25 in., stroke of the pulsator 6 in. Pulsations applied upstream.

A .. ΔP = 1 in.
B .. ΔP = 2·1 in.
C .. ΔP = 3·3 in.
D .. ΔP = 5·3 in.
E .. ΔP = 6·9 in.

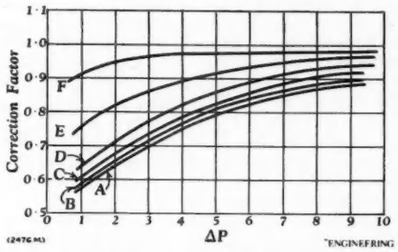

Fig. 7 Variation of the mean value of the correction factor for the tested range of frequency with pressure drop ΔP (inches of water) across the orifice for the different $\frac{d}{D}$ ratios. Stroke of the pulsator 9 in.

A .. $\frac{d}{D} = 0{\cdot}25$
B .. $\frac{d}{D} = 0{\cdot}375$
C .. $\frac{d}{D} = 0{\cdot}5$
D .. $\frac{d}{D} = 0{\cdot}625$
E .. $\frac{d}{D} = 0{\cdot}75$
F .. $\frac{d}{D} = 0{\cdot}875$

pressure wave and the mean pressure drop across the orifice are measured, then the flow may be determined with a coefficient of discharge as for steady-flow conditions. The flow-velocity wavelength thus determined, the measured pressure drop and the amplitude may be used for evaluating the coefficient of discharge for pulsating flow as a first approximation. By introducing this correction into the first calculations, a second approximation may be obtained.

The greater the diameter of the orifice the smaller is the non-dimensional number and, therefore, the greater is the deviation of the new coefficient of discharge from that for steady flow. This is in disagreement with the experimental finding that the new coefficient decreases with decreasing orifice diameter. When, however, this factor was incorporated in the non-dimensional number as d/D and also as $(d/D)^3$ the result did not indicate any improvement in the degree of scatter of the final results, suggesting

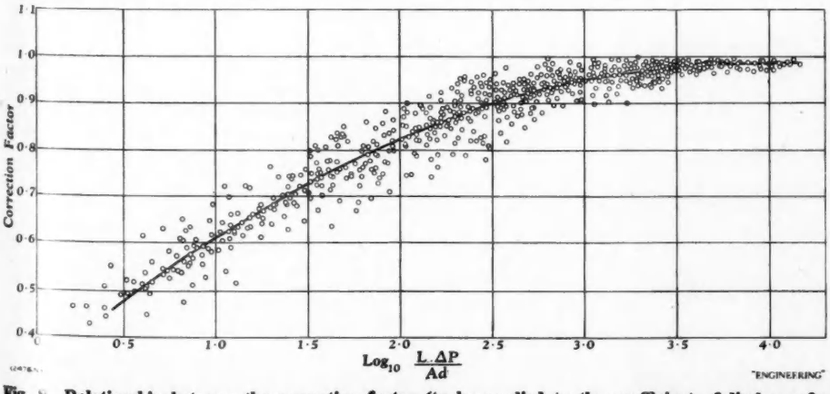

Fig. 8 Relationship between the correction factor (to be applied to the coefficient of discharge for steady flow of the air to account for pulsating flow) and the non-dimensional number $\frac{L\,\Delta P}{A\,d}$.

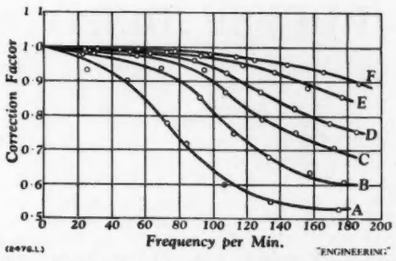

Fig. 5 Variation of the correction factor with frequency for various pressure drops across the orifice. Orifice diameter 1·25 in., stroke of pulsator 6 in., pulsations applied downstream.

A .. ΔP = 0·4 in.
B .. ΔP = 1·5 in.
C .. ΔP = 2·6 in.
D .. ΔP = 4·2 in.
E .. ΔP = 5·4 in.
F .. ΔP = 6·5 in.

that the complexity of the problem is more fundamental than has been thought up to now. In pulsating flow, pressure and velocity waves reach the orifice where partial reflection and transmission take place. The differential pressure is therefore a function of the instantaneous conditions in the upstream and downstream part of the orifice, and it should be possible to express it in terms of a constant value and such quantities as the amplitude of the advancing, reflected and transmitted pressure waves. These quantities may provide a dimensionless parameter which, when coupled with some of the parameters discussed above, may give an accurate coefficient for the measurement of any type of pulsating flow.

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CONCRETE TECHNOLOGY TRAINING COURSES

The Cement and Concrete Association have completed their arrangements for their training courses in concrete work to be given in 1955 at their Centre at Wexham Place, near Slough, Buckinghamshire.

Two series of general courses are available—one intended for engineers, the other for supervisory grades—and, in most cases, last just under a week, accommodation being available (for those requiring it) from Sunday evening to Friday afternoon. In addition to the general courses, an advanced course is also available for well-qualified and experienced engineers to enable them to keep abreast of the latest methods and techniques of structural concrete work.

Further details and forms of application may be obtained from the Association, at 52 Grosvenor-gardens, London, S.W.1.

REFUSE DISPOSAL AT CLYDEBANK

NEW MECHANISED PLANT

A new salvage and incinerating plant has been erected for the Burgh of Clydebank and was officially opened on December 8, 1954, by Sir James M. McNeill, K.C.V.O., M.C., F.R.S. The main contractors for the plant were Heenan and Froude, Limited, Worcester, the foundations, concrete and building work being carried out by the works department of the Burgh of Clydebank.

The new works is laid out on the existing depot at Whitecrook, Clydebank, and during erection, which commenced in 1951, the existing incinerators have remained in operation. Most of the original approach road has been retained, a new bridge connecting it with the tipping floor in the new plant.

The population served by the new plant is at present 46,400, and refuse collection is carried out by 19 motor vehicles, the last horse-drawn refuse carts having been disposed of in 1950.

The capacity of the plant is 85 tons of crude refuse per day of eight hours normal and continuous working, and the incinerator is capable of dealing with the " tailings " from this crude refuse in the same period.

Arriving at the entrance to the depot, loaded vehicles are weighed, then climb the approach road on to the tipping floor, and after manœuvering into position discharge their loads into a 100-cub. yard capacity reception hopper of steel plate construction, seen in Fig. 1. The tipping beam is 37 ft. long, providing ample space for more than one vehicle to unload at any time.

The hopper bottom consists of a slowly moving plate conveyor, which removes the refuse in a regulated flow and delivers it to the lower end of the elevating belt. The driving gear incorporates a two-speed gearbox so that the rate of flow may be controlled to suit the varying nature of refuse arriving from time to time.

SCREENING

The refuse is taken from the reception hopper to the primary screen by the elevating conveyor, the belt of which is troughed and runs between side plates which control bulky articles. An enclosed gallery houses this conveyor between the tipping and screening sections of the plant.

The primary screen is of large diameter, arranged horizontally and fitted with an internal steel spiral, which propels the refuse over the perforated plates as the screen revolves. The first section of mesh provides preliminary separation of dust, which is discharged by chute direct to the dust cross-conveyor. The second section takes out the larger material for treatment in the secondary screen. The rejects, or " tailings," pass over the end of the screen to the picking belt.

The smaller secondary screen is located so as to receive conveniently the larger material mentioned above, which it sub-divides into dust and cinders, passing to two cross-belt conveyors. The rejects from this screen pass to the lower end of the picking belt on their way to the incinerator. Both the screens are totally enclosed and are friction-driven by their rubber-tyred supporting rollers, which ensures smooth and silent running.

The two cross-belt conveyors and the main dust and cinders conveyors deliver into storage hoppers near the tipping house. An enclosed gallery houses the main conveyors and provides good access for maintenance. The hopper capacities are 15 tons of dust and 10 tons of cinders. Quick-acting roller-type doors fitted to the bottom of the hoppers permit rapid gravity loading to vehicles at yard level, which are weighed before proceeding to the coup.

Within the salvage room, men are stationed alongside the picking belt to remove articles of value such as paper, rags, bottles and bones, which are thrown into conveniently-placed chutes directing the salved materials to storage bins at ground-floor level, for ultimate collection by lorries.

Between the screening and incinerator houses this conveyor is enclosed in an inclined gallery. It discharges the refuse remaining after the picking operation on to the distributing conveyor in the incinerator house.

SALVAGING AND BALING METAL SCRAP

Within the salvage room and beyond the picking station a " Rapid " electro-magnetic overband separator is located over the belt for extracting ferrous metals, which are directed by chute to a storage enclosure at ground level, adjacent to the baling press.

The latter, a Heenan hydraulic double-ram baler, is of the self-contained type, with driving motor, mono-radial pump, two hydraulic cylinders and the necessary valves and piping, all mounted on a strong steel framework. The filling box is large enough to take a normal dustbin. It will also hold, comfortably, enough food cans or light metal scrap to make bales of 50 to 70 lb. weight. As the pressure exerted by the main ram is 60 tons, the bales are very dense and of convenient shape.

A troughed distributing belt conveyor runs along the upper part of the incinerator house over the furnaces. The travelling tripper working with this conveyor feeds the " tailings " to any of the grates as required. The movement of the tripper is controlled by push-buttons mounted on the chute which feeds the grates, so that the attendant on the charging floor can easily regulate the flow of refuse to the incinerators.

Fig. 1 The reception hopper, into which the refuse-collecting vehicles discharge on to a slowly-moving plate conveyor forming the hopper bottom.

INCINERATOR GRATES HYDRAULICALLY OPERATED

The two incinerators are of the steel-cased type, firebrick lined, each having three hydraulically-operated grates and a combustion chamber. The grates are built into carriages which are withdrawn by hydraulic power when clinker has to be discharged. The clinker is scraped off by the ploughing action of the back deadplates under which the moving grates pass.

Hydraulic power at 1,000 lb. per square inch pressure is provided by two three-throw pumps acting through a weight-loaded accumulator. A double-acting cylinder operates each grate.

As the incinerators are built on the first floor, arrangements are made for the clinker to fall by gravity from the grates, through cast-iron chutes, into enclosed chambers at ground level. There is one chamber to each grate and a skip used on the stillage system receives the hot clinker, which is then quenched by water passing at high pressure through special jets. A battery-operated truck first transports the skips to the vicinity of the crusher, where the clinker is tipped, afterwards replacing them in the quenching chambers ready to receive the next charge.

MANUAL CHARGING

A large charging door is provided in the arch over each combustion chamber, through which bulky trades refuse and other material not suitable for passing through the mechanical handling plant can be fed by hand. This refuse is elevated to the charging platform by a skip hoist.

The quenching chambers, furnace casings, and charging platform are ventilated and cooled by a system of ducts connected to the intakes of the forced-draught fans. Furnace castings are cooled by an air supply tapped off the main system which provides forced draught to the incinerator ashpits.

Steel-cased firebrick-lined downtakes and flues direct the incinerator gases to the dust catcher and chimney. In the dust catcher the gases impinge on the surface of water contained in a trough specially designed to facilitate the removal, by gully emptier, of the solids which are collected. The chimney, built in brickwork and lined with firebricks throughout, has an internal diameter of 7 ft. at the top and is 120 ft. high.

The skip hoist, which has a capacity of 3 cub. yd., is electrically operated and controlled by push-buttons at ground level, and automatically discharges its contents on to the feeding platform. In an emergency ordinary household

Fig. 2 The incinerator charging platform.

refuse could be deposited on to the charging platform and then fed to the grates through normal top doors.

Situated at one end of the incinerator house is a clinker crusher of the double-roll type, which breaks down the quenched clinker as fast as it is shovelled into the reception chute. Another chute below the crusher feeds into the boot of a bucket elevator, which discharges into a lorry backed into the building at yard level.

To improve the working conditions in the screen and picking sections of the plant, dust extraction equipment is fitted. Dust suspended in the atmosphere is sucked into hoods and transferred by pipes and fan to a filter, from which it is removed in paper bags. An experimental system has been designed to control the rising dust over the crude-refuse reception hopper.

Electric power for lighting, driving the various motors, and for energising the magnetic separator, is obtained from a low-tension switchboard in the screen house, and is fed to each of the main sections of the plant where local distribution boards are provided. A comprehensive system of sequence interlocking is incorporated with the motor starters.

The plant is housed in three new buildings with interconnecting galleries. The buildings are of steel-frame construction with brickwork panels and steel sashes, the tipping and screening houses having boarded and slated roofs while the incinerator house roof and galleries are clad with corrugated asbestos-cement sheeting. All the foundations and floors are in reinforced concrete, those for the incinerator house, flues, dust catcher, and chimney being supported by reinforced-concrete piles. Accommodation for the workmen remains in the old buildings.

REVERSIBLE HIGH-SPEED HYDRAULIC MOTOR

LOW-INERTIA UNIT

A range of high-performance reversible hydraulic motors intended primarily for use in aircraft, particularly for powered flying controls, has been introduced recently by Integral Limited, Birmingham-road, Wolverhampton. Made by high-precision techniques and subjected to rigorous individual inspection at each stage of manufacture, and to extensive calibration and endurance tests, these motors have applications wherever quick speed of response and a high degree of reliability combined with low weight are prime considerations.

The motors are of the piston type driving a swashplate mounted on a cranked portion of the driving shaft, the design being based on the well-tried Beacham swashplate pump principle. The inlet and outlet valves controlling the flow of fluid to the pistons are operated by an eccentric integral with the driving shaft. The motors are designed for operating at fluid pressures up to 4,000 lb. per square inch and are available in a range of torque ratings from 7·5 lb.-ft. at 2,400 lb. per square inch at 1,500 r.p.m. (maximum r.p.m. 8,000) to 31 lb.-ft. at 4,000 lb. per square inch at 1,500 r.p.m. (maximum r.p.m. 4,500). Standard cylinder blocks are employed in all sizes but the bores are varied to suit pistons ranging in diameter from 0·3 in. to 0·5 in.

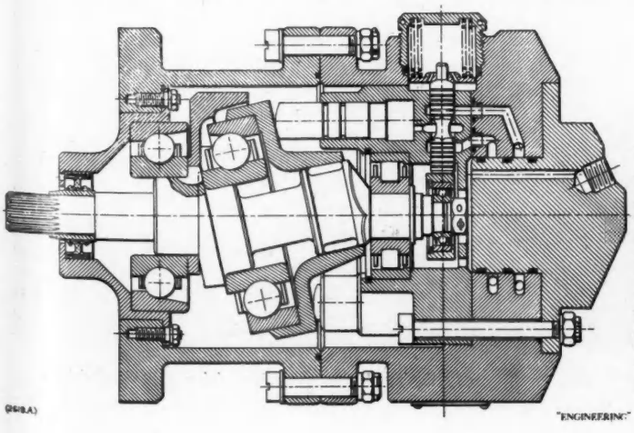
APPLICATION TO HELICOPTERS

The motor shown in the accompanying illustrations, the 197 Mark 2, is the largest model, and is in production for the winch drive on Westland Dragonfly and Whirlwind helicopters. In this version the end cover is provided with threaded ports to take standard pipe unions, whereas the Mark 1 range is designed with integral fluid passages for direct-mounting to a flying control unit.

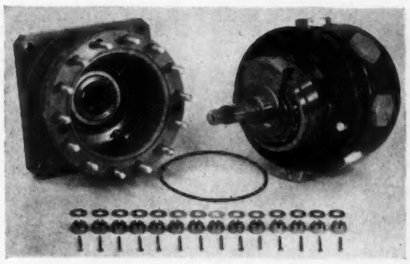
The driving shaft, in hardened alloy steel, is machined to form the inclined crank carrying the swashplate, and, 90 deg. out of phase with the crank, the valve-operating eccentric. A high surface finish on the swashplate to within 1 micro-inch is obtained on a Rockwell Lapmaster machine. The drive shaft is carried by a ball thrust bearing at the driving end and by a roller bearing between the crank and the eccentric, and is sealed where it emerges from the casing by a single synthetic rubber seal bearing on a nitride-hardened steel sleeve shrunk on to the shaft. (An alternative form of seal is fitted on the Mark 1 motor, in which a spring-loaded polished steel rubbing member secured to the shaft bears on a carbon ring mounted in the casing.) The shaft is balanced by a weight keyed to it. The eccentric carries a ball bearing on which is mounted a driving ring operating the inlet and outlet valves.

As may be seen from the sectional drawing below the casing is in two halves bolted together, one half of the casing carrying the main shaft-bearing housing and the shaft oil seal, the other half enclosing the cylinder block, to which it is attached by seven bolts which also secure a connector cover housing the fluid inlet and outlet connections. The shaft roller bearing is carried in the cylinder block.

The cylinder block, of high-grade cast iron, has seven symmetrically-disposed bores parallel to the driving shaft axis. The bores are ground and honed to match individual pistons (with a maximum clearance of 0·0001 in.) which are machined from alloy-steel bar hardened and ground to the requisite finish (2 micro-inch),



The motor is of the swashplate type, the swashplate being driven by seven pistons in bores parallel to the drive shaft. Valves controlling the fluid flow to the pistons are actuated by an eccentric integral with the drive shaft.



Integral hydraulic motor, one of a range of light-weight quick-response motors used for helicopter winch drives.

and are provided with spherical ends which bear on the swashplate.

The valve bores are arranged radially, each in line with a cylinder and adjacent to a cylinder head to which it is connected by fluid passages. The valves are in the form of waisted pistons retained by spring caps. They are initially made slightly oversize in length and then individually timed and reduced in length as necessary to ensure that the changeover from pressure to return is accomplished instantaneously.

Each valve bore has three annular ports, the centre one communicating with the adjacent cylinder head and the other two being connected to the main fluid inlet and outlet connections. In all valve positions, the centre port is aligned with the waisted portion of the valve. When the latter is displaced from its central position, either the fluid pressure line or the return line is uncovered and thus connected to the centre port.

The eccentric driving ring is so arranged relative to the swashplate that when a driving piston is at either end of its stroke its valve will be at mid-position. If the piston is at top dead centre, any rotation of the shaft will move the valve allowing fluid under pressure to enter the cylinder and force the piston against the swashplate resulting in rotation of the crankshaft. The pistons not under pressure will be returned by the swashplate, the fluid in their cylinders being expelled and directed by the valves into the return line. Changeover of the pressure and return lines by an external changeover-valve will reverse the direction of movement of each piston and thereby cause a reversal of the rotation of the shaft.

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PRESTRESSED-STEEL BERTHS FOR TANKERS

Increased Capacity for Absorbing Momentum

Fender structures that are prestressed so as to increase their capacity for absorbing ship momentum have recently been erected in front of some new wharves built for the Shell Petroleum Company at Pulo Bukom, Singapore. The structures, devised by the consultants for the wharves, Sir William Halcrow and Partners, Westminster, consist of a heavily-reinforced concrete beam, 240 ft. long and weighing approximately 1,100 tons, mounted on the top of a line of forward-raking piles of high-tensile steel. The weight of the concrete cap, combined with the forward rake of the piles, gives the latter a prestress, so enhancing their capacity to absorb the momentum of the ship by reverse bending. Ships having displacements of up to 60,000 tons will be using the wharves and, due to the prevailing conditions, berthing speeds of between 9 and 12 inches per second are to be expected. The design was further complicated by the need for siting the structures in deep water above a steeply-shelving sea bed.

The wharves, provided with shore facilities to allow loading and discharge rates of from 1,000 to 1,500 tons per hour from the world's largest tankers, consist of independent jetty heads constructed behind the protection of the fender structures.

PRECISION CASTING BY THE LOST-WAX PROCESS*

DEVELOPMENTS IN THE TECHNIQUE FROM 1949 TO 1953

By J. S. Turnbull†

The author's first paper on the lost-wax process of precision casting‡ was a general description of the process as practised in Britain at that time. A second paper is concerned with its development in the precision casting shop of the Metropolitan-Vickers Electrical Company, Limited. This "lost-wax" foundry differs in many respects from other foundries. Not only has it to satisfy a demand for large quantities of gas-turbine components, but also to supply, for use in the company's electrical and mechanical products, considerably larger castings of all sizes and complexities, for the production of which the original process was totally unsuited.

One of the main attractions of the lost-wax process is that it can handle both long-run and short-run production orders for relatively cheap die costs. Thus, orders for from one to fifty components can be made by use of simple plaster-of-Paris dies for a tool cost of £5. Orders for from 50 to 15,000 can conveniently be handled with a bismuth-tin die with tool charges of from £20 to £50. Long-run orders of 15,000 or above, should be carried out with steel dies, with tool charges of from £50 to £120.

WAX-INJECTION MACHINES

Three types of machine are in operation, namely, a universal machine, a semi-automatic machine and a vacuum injection machine. The universal machine can inject patterns of all sizes and shapes and is designed to inject wax into the die box at the lowest point, thereby forcing the air to rise upwards and escape through the die parting line. To enable easy working of this system, the machine is hinged on trunnions. The wax is injected with the die vertical, and the wax pattern is removed with the die horizontal. Another universal machine working on the same principle as that described, can inject six dies simultaneously.

In the semi-automatic machine, the wax is injected through the die parting line, the die halves being parted hydraulically. The pattern is removed by ejector pins operating through the stationary half-die.

The vacuum injection machine is a specialised machine for use with complicated dies. The die is cleaned, coated with parting medium, and located on the die platen. The platen is now raised pneumatically until the die is clamped in position. A metal cover is raised pneumatically by two ancillary pressure cylinders, vacuum sealing on a rubber gasket. The system is now evacuated and wax under pressure is introduced through a slide valve on the top plate. Compressed air to eliminate contraction draw is unnecessary on this machine, owing to vacuum pressure on the outer faces of the wax pattern. Excellent surface finish is obtainable, but cycle times are longer than for universal machines. A wax rotor assembly produced on a vacuum wax-injection machine is seen in Fig. 3.

The principles of operation are: (1) All dies are fed with wax at the lowest point, to assist in removal of the air, and to eliminate turbulence; (2) all dies are injected with the parting line in the vertical plane, to facilitate the removal of air; (3) all dies are lubricated with ethyl silicate or other non-sticking parting media, to facilitate the removal of the wax patterns; (4) where air locks do occur, the die is vented on the parting face; (5) conical locating pins are used for correct die register; (6) steel back-plates are fixed to soft-metal dies to avoid distortion when clamping; (7) the injection hole is ¼ in. or less in diameter, according to the size of the wax pattern; (8) After extraction of the wax pattern from the die, all traces of ethyl silicate are carefully removed. Principles (1), (2) and (4) do not apply to the vacuum-injection machine.

DESIGN OF ASSEMBLY OF WAX PATTERNS

The method by which the casting is done will determine the wax-pattern assembly. Two main methods of casting are used, namely, centrifugal casting and gravity casting. As might be expected, the weight ratio of runner to component part is considerably lower for centrifugal castings than for gravity castings. The following approximations are given: gravity-cast components, 30-50 per cent. of metal poured; centrifugally-cast components, 50-60 per cent. of metal poured.

After the type of wax assembly has been decided, the next step is to plan the wax assembly on the basis of a total wax weight of 2 lb. This calculation is made on a casting weight of 15 lb. of metal; the ratio of metal weight to wax weight is 7½.

The wax patterns can now be assembled by two different methods. In the first, or hand assembly, the assembly is built up with the aid of dental spatula. All wax runners made for hand assembly are cast in plaster moulds. The second is the pouring-fixture method, in which jig assembly is used. This method involves a small tool cost, but reduces the assembly time by 75 per cent.

INVESTING AND CASTING

Before recent developments in the processes of investing and casting are described, it will be of advantage to analyse the processes as set out in the author's paper of 1950 and to comment on their deficiencies. As described in that paper, the wax-pattern assembly was invested with an ethyl-silicate-bonded slurry, the wax was melted out by oven treatment, the mould was then fired at 1,000 deg. C. to remove all traces of wax, methylated spirits, water, etc., and to establish maximum mould porosity. The mould was cast with 5 lb. of molten metal, and an air pressure of 2-10 lb. per square inch. The mould was then knocked out and the castings shot-blast, cut-off, etc. By concentration on process control it was possible to mass-produce castings with a scrap percentage of less than 30 per cent.

In considering the above, the most important development must necessarily be the reduction of scrap to the lowest possible percentage. An analysis of defective castings shows that scrap is mainly due to: (1) Refractory inclusions; (2) trapped gas; (3) lack of definition; and (4) defective surfaces.

REFRACTORY INCLUSIONS AND TRAPPED GAS

The simplest way in which inclusions occur is when pieces of refractory fall into the mould cavity just prior to casting. This can be overcome by the provision of a trap. It will be noted that a trap can be provided much more readily in a centrifugal mould where the metal is thrown out sideways than in a gravity mould where the casting cavities are usually immediately below the mould ingate.

Trapped gases may be of two types: (*a*) gases which come out of solution while the metal is solidifying in the mould—this is

* Paper entitled "Development of the Lost-Wax Process of Precision Casting, 1949–53," which was read before the Institution of Mechanical Engineers, on Friday, December 31, 1954. Abridged.

† Works Development Engineer, Metropolitan-Vickers Electrical Co., Ltd., Manchester.

‡ Turnbull, J. S., see *Proc.I.Mech.E.*, vol. 162, page 66, 1950 "'Lost Wax' Process of Precision Casting."

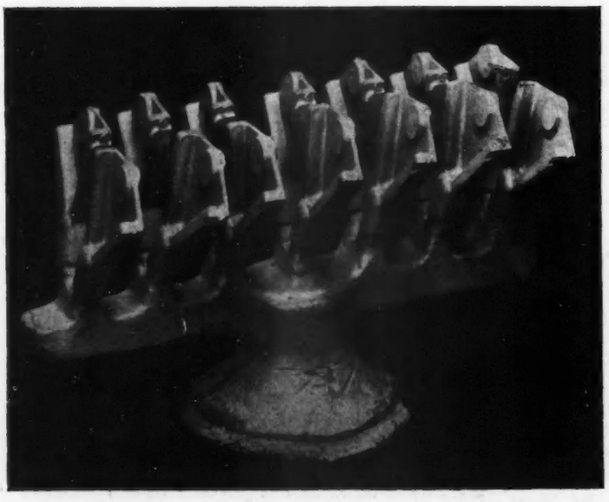


Fig. 1 Badly-designed wax assembly showing defects in casting below feeding head.

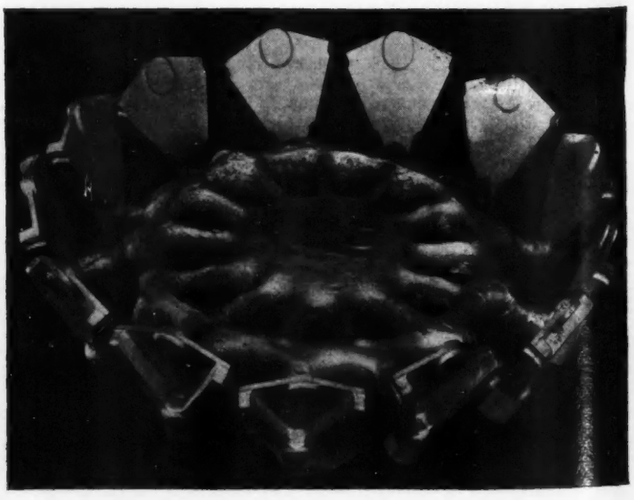


Fig. 2 Correctly designed wax assembly giving best disposition of castings.

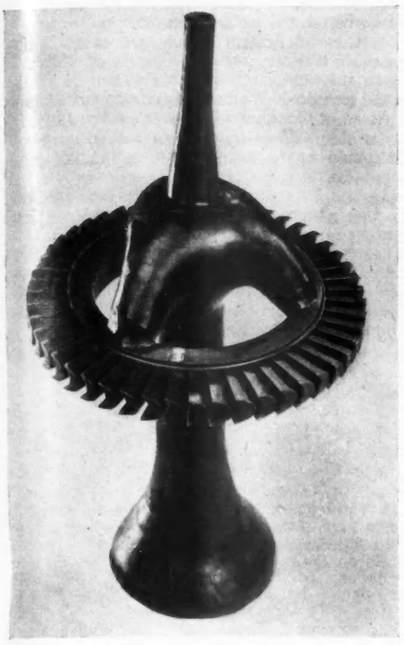


Fig. 3 Wax rotor assembly produced on a vacuum wax-injection machine.

typical of mild steel; the cure is to kill the metal or to use alternatives; in borderline cases, gassing can be avoided by allowing the casting to solidify under considerable pressure; and (*b*) gases which are trapped in the mould when the metal is poured into the cavity. These gases are normally oxygen, nitrogen, and carbon dioxide. Gas defects probably account for most of the scrap in precision-casting.

The author's view concerning rate of pouring is that moulds should be poured as quickly as possible, and if gas is trapped it is the fault of either low mould permeability or inaccurate metal pressures.

Permeability in solid-mould techniques is always dependent on the effective removal of the wax. If the wax patterns are assembled in such a manner that the wax cannot drain out, the wax must be burnt out during the firing cycle.

Wax-removal should be dealt with adequately, either by correct disposition of the wax patterns, or, where shape makes this impossible, by joining ¼-in. diameter wax rods from the lowest part of the wax patterns to the main runner.

" Investment X " moulds, described below, do not, however, suffer from the same disadvantages since the wax is removed by the solvent action of trichlorethylene vapour. Even in instances where the wax cannot run out of the mould, the trichlorethylene wax solution will drain out through the walls of the shell mould.

Investigation into the use of air pressures has convinced the author that the best results are obtainable with a metallostatic head alone, and that the use of air pressure is an unnecessary complication. Castings made by this means have a limitation in sectional thickness of approximately $\frac{1}{16}$ in. when casting is done in solid moulds of optimum permeability. Where pressure casting is required by virtue of thin sections and high definition, centrifugal pressure will give consistently good results. It is possible by this means to make castings with sections varying from $\frac{1}{16}$ in. to 0·010 in.

DEFINITION AND SURFACE DEFECTS

Where lack of definition is not due either to mould permeability or to inaccurate pressure, it may be due to: (*a*) metal cast at too low a temperature; or (*b*) the disposition of the mould cavities around the main feeder.

(*a*) Casting metal at the specified temperature relies on workmanship of high order; it is also dependent on reliable pyrometry, and the quality of the furnace crucibles, insulation, etc.

(*b*) Where the best possible results are required in the making of accurate castings, it is desirable that the pattern cavities should be spaced symmetrically relative to the main feeder. To illustrate this point, two groups of castings are shown in Figs. 1 and 2.

Fig. 1 has the castings spaced evenly along a cross runner, with the main runner connected in the centre. In such a case the castings immediately below the main runner will be of different quality from that of the castings on the outside. This is because the centre cavities fill first, but do not get any pressure from the metallostatic head until the outer cavities have filled. The outer cavities receive pressure much more quickly.

The second group (Fig. 2) are spaced symmetrically around a disc feeder. Preferably, this set-up should be centrifuged, but even if gravity methods are employed, the results will show a considerable improvement.

Defective surfaces may be caused by a number of operational failures. The primary coat may separate from the wax pattern during investment, allowing the investment liquid to fill the cavity thus formed. The cast surface will be proportionately misplaced and rough, and " furred " with silica deposit. The secondary coat may separate from the primary coat, allowing the metal to break through. In this event the casting will have a rough thin skin of metal cast on to its surface which when reduced by grinding will form a subsidence in the casting.

Bad packing by vibration will cause a surface to collapse under casting stresses. This is a principal weakness in normal solid-mould technique, and is eliminated in the Investment X process by the use of multiple-dip coats. Bad spraying of the primary coat will cause the surface layer formed to lack cohesion. When the casting is made, this surface will erode away, giving a rough finish with a loss of accuracy. The use of refractory binders not fully hydrolysed will cause weak moulds.

Too high a metal-pouring temperature will cause heavy penetration of the primary coat during casting. Defective surfaces may also be caused by the contraction of a casting which is not effectively fed. This usually takes the form of " hot spotting " in sharp corners and recesses. Finally, oxide films, etc., will produce negative errors in cast surfaces.

INVESTMENT X PROCESS

The wax-pattern assembly is first spray-coated or dip-coated in the usual manner, and is then provided with a multiplicity of superimposed dip coatings, which result in the pattern being invested with a shell of refractory materials of substantial thickness. After formation of the shell, the wax is removed by immersion in trichlorethylene vapour; the mould is then completed by packing the shell in a Nimonic 75 canister with dry refractory material.

The foremost advantage of the Investment X process as compared with the solid-mould technique is its simplicity. From the point of view of shop management the following points should be emphasised. No preparation, assembly and stripping of mould boxes, bases, and extensions is needed. No vibration is necessary. No drying oven is required so that the risk of explosion is eliminated. No knocking out of moulds is necessary; the mould can be poured out. Slurry mixing is cut to the mixing of a single-dip bowl. Handling and re-grinding of mould materials is cut by 75 per cent. Owing to the greatly reduced weights of the shell moulds, handling problems are considerably eased. On a given floor area the Investment X process will give between two and three times the production obtained by average solid-mould methods. Simplified methods of investment lead to reduced breakage. Since the Investment X process is simpler than solid-mould techniques, unskilled labour can be more easily trained.

From the technical viewpoint, the following advantages are apparent. Removal of the wax by the trichlorethylene vapour gives the mould a consistent permeability. The mould

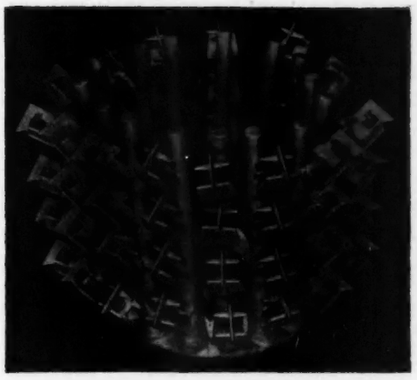


Fig. 4 Aluminium armature castings, cast centrifugally.

Fig. 5 Aluminium air-intake casting, cast centrifugally.

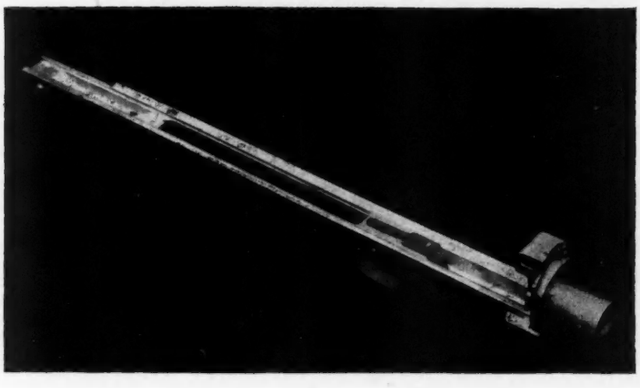


Fig. 6 As in the case of this Bren-gun slide, finished length 22 in., it is not always convenient to cast centrifugally, and a reduction in the pressure outside the Investment X shell will then help to fill the mould with metal.

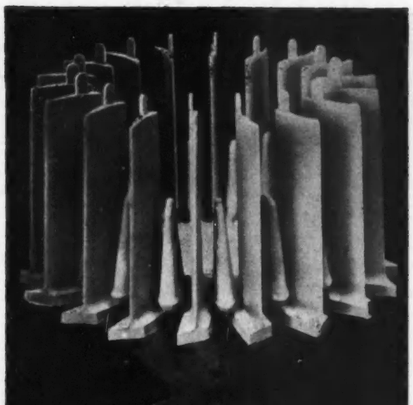


Fig. 7 Centrifugal assembly of sprayed wax patterns showing tapered heaters interposed between air-compressor blades. The heaters enable progressive solidification to give sound castings.

has a much higher permeability. The smaller thermal capacity of the shell reduces the likelihood of short-run castings and enables moulds to be poured at the lowest possible temperatures.

The formation of refractory solids, due to the investment liquid attacking the wax or filling the space between wax and primary coating, is avoided. Mould cracking is eliminated. The dissolving of the wax pattern in the trichlorethylene bath has no ill effects on the primary coating (during the de-waxing cycle in solid-mould technique, the expansion of the wax can cause flaking of the primary coat). Progressive solidification can be achieved by cooling parts of the shell before the metal is cast. This can be done by coiling a heat-resistant metal tube locally around the shell mould, and blowing cold air through it for several minutes before casting the metal.

Owing to the substantially reduced quantities of materials used to make shell moulds, it is economically feasible to use first-class refractories, bonding materials, etc. The use of hollow wax patterns is possible in the Investment X process, whereas the solid-investment process is liable to collapse the pattern.

The unscientific disposition of a large number of wax patterns in a given volume as required by the economics of solid-mould technique is no longer necessary. The patterns can now be disposed symmetrically around the main runner, either for gravity or centrifugal casting. The shell mould produced by multiple dipping and stuccoing is of identical texture on all faces whereas a solid mould which is vibrated will have a weak surface on the underside of the wax pattern owing to differences in packing of the particles. Finally, larger castings can be made.

SOLID-MOULD TECHNIQUE

Where a component such as a rotor has to be considered for investment (Fig. 3), the solid-mould technique is preferable, since it fills the small spaces between the blades and prevents metal penetration. If Investment X is applied, the coat build-up is too thin to be effective, and there is always likely to be an air pocket between the two coatings, which may cause investment failure.

This is not only true of rotor castings, but also of all instances where internal shapes do not allow the Investment X shell to be thick enough. It is not always necessary that a solid mould should be made, since it is possible to compromise between the two techniques; and it is quite practicable to invest part of a wax pattern by solid-mould technique, and to complete the mould by Investment X.

The use of the Investment X method becomes more and more desirable when larger castings are being considered. The shells are much more easily handled than solid moulds, and differential expansions and contractions are not as detrimental as for solid-mould technique.

CENTRIFUGAL CASTING

The use of centrifugal casting enables accurate pressure-casting to be done with a good yield. Furthermore, it uses, wherever possible, a symmetrical pattern assembly resulting in a high degree of casting accuracy. Metallurgical tests generally show better homogeneity, and greater soundness, than can be obtained by gravity casting. The use of a centrifuge is beneficial in avoiding turbulence with resulting trapped gas. Because each particle of metal is pressurised by its own centrifugal force very little trouble arises with short-run castings. The speeds used vary from 50 to 1,000 r.p.m. according to the nature of the casting, and the mould gate is always on the axis of revolution. After the metal has been poured, the mould is spun for a further 7 minutes. Figs. 4 and 5 show various centrifugally-cast assemblies.

VACUUM CASTING

Vacuum casting is often intended to refer to the melting and casting of metal in vacuum. In this context, however, it is limited to the exclusion of gas from the mould cavities at the moment of pouring.

It has already been stated that a main advantage of the Investment X shell mould over the solid mould is the higher definition obtainable owing to the total exclusion of the gas in the mould cavities by the incoming metal. There are, however, instances where this advantage is precluded owing to thinness of casting section, length, etc. Furthermore, the shape may not lend itself to centrifugal casting. Fig. 6 shows for example, a Bren-gun slide, cast length 25 inches. In such instances, the reduction of atmospheric pressure outside the walls of the Investment X shell mould can be of great assistance in filling the mould with molten metal.

A second method of casting is designed to remove a high percentage of air and gas from the mould cavities before pouring the metal. In this instance, the mould (at 1,000 deg. C. or at any other desired temperature) is placed in a metal canister with a ceramic pouring funnel sealed into the lid. The pouring funnel is blanked off by a metal diaphragm located at its smallest diameter. The canister is then evacuated to any desired pressure giving a "rough" vacuum. Molten metal is poured quickly into the funnel which will fill to the top before the diaphragm burns through. The metal then pours into the mould and the casting is made.

PROGRESSIVE SOLIDIFICATION

When the shape and sectional differences of a casting make it difficult to obtain a sound casting free from shrinkage defects, it is possible to promote thermal gradients in the mould as an effective remedy. The methods used are as follows :

(1) Use of cooling slots in a solid mould at 1,000 deg. C. cold air is blown through the slots for a specified time.

(2) Use of a combination of heating and cooling slots in a mould at 1,000 deg. C., whereby a much higher gradient is attained. A suitable mixture of aluminium and iron oxide is burnt in the heating slot to elevate the mould temperature to 1,200 deg. C. and the cooling slots reduce the mould temperature to 600 deg. C.

(3) Use of a heat-resistant metal tube which is coiled around an Investment X shell mould adjacent to the heavy section of the casting. Its employment would have promoted shrinkage porosity in a casting made by a normal technique. Cold air is again blown through the tube for a specified time, to reduce the mould temperature locally before the metal is poured.

(4) Use of heaters which are cast simultaneously with the required components. Fig. 7 shows this applied to the Investment X shell-mould technique when casting compressor blades of constant sectional area. The presence of the heater slows down the rate of solidification of the blade at its root section and promotes soundness.

(5) Use of metal chills which are fixed to the wax patterns at those sections where quick freezing is required to promote soundness.

The five instances quoted above are not methods which should be used liberally. Wherever it is possible for the casting design to be modified to a shape better suited to progressive solidification, this course should be taken.

* * *

LAUNCHES AND TRIAL TRIPS

M.S. "TANK MONARCH."—Single-screw oil tanker, built and engined by the Götaverken Shipyard, Gothenburg, Sweden, for the joint ownership of Skibs A/S Panama, Skibs A/S Herbjörn, and Sigurd Herlofson & Co. A/S, all of Oslo, Norway. Main dimensions: 649 ft. 8 in. overall by 80 ft. 6 in. by 44 ft. 9 in.; deadweight capacity, 28,820 tons on a draught of 33 ft. Götaverken nine-cylinder single-acting two-stroke Diesel engine, developing 8,200 b.h.p. at 112 r.p.m. Speed, 14½ knots, fully loaded. Delivered, December 8.

S.S. "IVERNIA."—Twin-screw vessel with accommodation for 110 first-class and 830 tourist-class passengers, built and engined by John Brown & Co., Ltd., Clydebank, for the Canadian service of the Cunard Steam Ship Co., Ltd., Liverpool. Main dimensions: 608 ft. 3 in. by 80 ft. by 46 ft. 3 in.; gross tonnage, 22,000. Vessel propelled by geared steam turbines and fitted with Denny-Brown stabilisers. Launch, December 14.

M.S. "FERNVALLEY."—Single-screw cargo vessel with accommodation for twelve passengers, built and engined by Alexander Stephen and Sons, Ltd., Glasgow, for Det Bergenske Dampskibsselskab, Bergen, Norway. When completed, the vessel will be transferred to Fearnley & Eger, Oslo, Norway, for use on the joint West-African service of Fearnley & Eger, Det Bergenske Dampskibsselskab, and Rederi A/B Transatlantic, Gothenburg, Sweden. Main dimensions: 400 ft. by 57 ft. by 35 ft.; gross tonnage, about 4,550; deadweight capacity, about 6,530 tons on a draught of 23 ft. Stephen-Doxford four-cylinder two-stroke opposed-piston oil engine. Launch, December 14.

M.S. "INNESMOOR."—Single-screw cargo vessel, built and engined by Hawthorn Leslie (Shipbuilders), Ltd., Hebburn-on-Tyne, County Durham, for the Moor Line, Ltd. (Managers: Walter Runciman & Co., Ltd.), Newcastle-upon-Tyne. Main dimensions: 423 ft. between perpendiculars by 58 ft. by 29 ft. to upper deck; deadweight capacity, 9,540 tons on a draught of 25 ft. 8⅜ in.; gross tonnage, 5,574. Hawthorn-Doxford four-cylinder opposed-piston oil engine, developing 3,300 b.h.p. at 108 r.p.m. in service. Engine equipped for burning heavy fuel oil. Service speed, about 13 knots. Trial trip, December 15.

M.S. "BORDER MINSTREL."—Single-screw oil tanker, built by the Blythswood Shipbuilding Co., Ltd., Scotstoun, Glasgow, for the Lowland Tanker Co., Ltd. (Managers: Common Brothers Ltd.), Newcastle-upon-Tyne. Main dimensions: 515 ft. between perpendiculars by 69 ft. 6 in. by 37 ft. 6 in.; deadweight capacity, about 16,150 tons. Rowan-Doxford six-cylinder two-stroke opposed-piston oil engine, developing 6,800 b.h.p., constructed by David Rowan & Co., Ltd., Glasgow. Speed on trial, 15½ knots fully loaded. Trial trip, December 16.

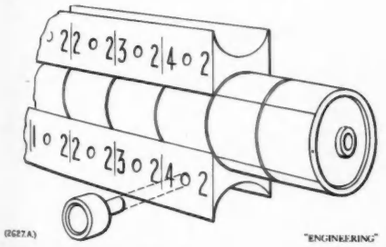
M.S. "HÖEGH SKEAN."—Single-screw oil tanker, built and engined by the Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, for the joint ownership of A/S Bisca and A/S Alliance (Managers: Leif Höegh & Co. A/S), Oslo, Norway. Eighth vessel built for these owners. Main dimensions: 526 ft. between perpendiculars by 69 ft. 9 in. by 39 ft. 3 in.; deadweight capacity, 17,900 tons on a draught of 30 ft. 4¾ in.; oil-tank capacity, 867,000 cub. ft. B. and W. nine-cylinder Diesel engine, developing 9,000 b.h.p. Speed, 15¼ knots. Delivered, December 16.

PROGRESS CHART

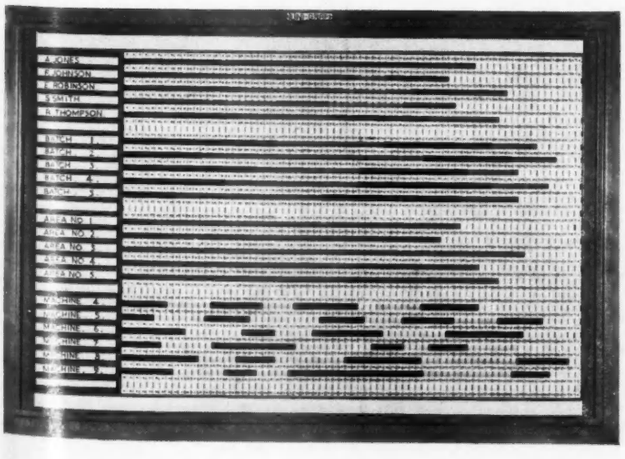
Ten Colour Codes Without Loose Parts

A newcomer to the range of progress and business charts now available is the "Unigraph" which is being produced by Office and Factory Equipment (Leeds), Limited, 10 Merrion-street, Leeds, 1. One of the main advantages claimed for this is that there are no loose tabs or cards to go astray. The chart, which is designed for wall mounting, is made up of rows of rotatable coloured plastic cylinders mounted between white plastic scales, as can be seen in the sketch below, which shows the basic assembly. Each cylinder has five bands of colour, white, black, yellow, green and red, and can be rotated to display either the whole of one colour or half of two; in this way ten different indications can be obtained. The white scales are engraved with consecutive numbers for the cylinders and are, in addition, drilled to take a coloured plastic plug to give further coding facilities. There is an index column at the left of the chart.

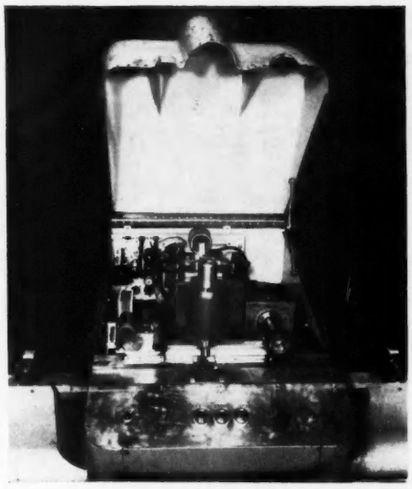
At present, three models are being made, all having the same overall dimensions of 37 in. wide, 26 in. high and 1½ in. thick but giving alternative arrangements of the indicators. The first, as shown in the illustration, has 25 rows of 72 indicating cylinders, the second 50 rows of 24 indicators arranged in two columns and the third 75 rows of 24 indicators arranged in three columns but with smaller index columns (only 2 in. wide) than the other two. The frame and index holders are of aluminium, painted dove-grey, and the whole is mounted in a block-board frame which will not warp. Transparent or solid covers can be fitted, hinged at the ends, to ensure that no accidental or unauthorised changes can occur and to keep the chart itself clean. This, and the fact that it will not warp, enables the chart to be mounted in any part of the factory wherever it is most convenient. It has been found that, in the machine shop, the three-column model with the largest number of subject rows is the most useful.



The indicators are plastic cylinders, each with five bands of different colours, mounted between white plastic scales. A plastic plug offers additional coding.



The version of the progress chart shown here has 25 rows of 72 indicators. Other models have 50 or 75 rows of 24 indicators, the last having proved itself the more valuable in most machine shops.



On this machine holes are pierced in the traversing workpiece at positions determined by a master tape moving synchronously with the workpiece.

PIERCING MACHINE CONTROLLED BY PHOTO-ELECTRIC CELL

To expedite the work of punching rivet holes at varying pitch in batches of strip or sectioned metal components—an operation involving tedious concentration when carried out by normal methods—the Folland Aircraft Company, Limited, Hamble, Southampton, have recently developed an electronically-controlled machine (patents pending) which automatically locates and pierces the holes.

The machine comprises a hydraulically-operated 3-ton punch, a photo-electric detector unit, and the associated electronic control gear, grouped in a central casing which is shown in the accompanying illustration; and a power-operated carriage carrying the material to be pierced and running on rollers supported by the machine framework. The carriage is driven through friction rollers by an electric motor and can travel in either direction, as selected by push-button switches. At each end of its travel the carriage is stopped by limit switches interlocked with the control switches.

Also carried on the traversing carriage is a "master" strip of thin steel tape, ⅛ in. wide, of the type used for binding packing cases, in which the pitch of the rivet holes to be punched has been previously set out by hand-pierced slots. As the carriage moves across, the master strip is passed through the photo-electric detector unit, which consists of a lamp disposed on one side of the master strip and a photo-electric cell on the opposite side. When the passage of a master slot allows light from the lamp to illuminate the photocell, an amplified signal from the latter operates a timing relay which opens a hydraulic valve admitting pressure to the ram operating the piercing unit, and which also operates a hydraulic clutch disengaging the carriage drive so that the work is held stationary while the hole is being pierced. After a delay period, pre-selected to suit the gauge of the work and not dependent on the duration of the photocell signal, the electro-hydraulic valve is closed allowing the ram to be retracted and the clutch to re-engage under spring pressure.

* * *

DEVELOPMENT OF THE THERMIONIC VALVE

About 1920, Mr. R. McVitie Weston, a solicitor with scientific leanings, became interested in the various types of thermionic valves then available to the amateur constructor and by 1938 had collected some 2,000 specimens, including one of Fleming's original diodes, a Lee de Forest triode, and a Lieben-Reisz gas triode. This historical collection has now been assembled in the hall of the Radio Building of the New Southgate works of Standard Telephones and Cables, Limited, and it is hoped, with the co-operation of valve manufacturers and others, to add further suitable items, thus providing material of great interest for the student. A complete catalogue is in preparation.

* * *

HIGH-FREQUENCY IGNITION SYSTEM

An ignition system which employs the normal type of igniter plug with an additional boosting device has been developed by the Plessey Company, Limited, Ilford, Essex, in conjunction with the patentees, D. Napier and Son, Limited, 211 The Vale, London, W.3. The system is designed for free-running engines such as turbines, or for the ignition of oil-fired boilers, and is particularly suitable for the oils of low volatility which are normally used in these cases.

The supply is fed to an induction coil, and the high-voltage output from the secondary of the coil is passed through a high-frequency transformer; at the same time the primary of the induction coil charges a storage capacitor. The insulated gap of the igniter plug is ionised by the high-frequency surge, and when an ionised path has been established the storage capacitor is discharged across the gap; the discharge of the capacitor is at relatively low voltage and is of high energy content.

The repetition rate of this discharge is approximately 50 per second, and the initial firing delay after switching on is less than 10 milliseconds. These factors have proved to be of importance in cases where considerable quantities of unburnt fuel would accumulate in the combustion chamber if there were a low repetition rate and a long initial firing delay. Such fuel flooding could easily occur in small turbines where it is vital that a spark should appear during the short period of favourable combustion conditions. The occurrence of a spark during this period means that much less energy is necessary for ignition than would be needed at a less favourable time, such as may occur with system having a low repetition rate.

A suitable energy content, (actually dissipated at the plug) for fuels of low volatility has been found to be of the order of 0·15 joules per spark with a dissipation time of between 50 and 100 microseconds. Because of the inter-related effects of plug position, chamber shape, method of fuel injection and air flow, the company are collaborating with manufacturers by providing experimental units to determine the best arrangements for various installations.

HARDNESS TESTING ON LARGE SPECIMENS

PORTABLE VICKERS DIAMOND-INDENTOR MACHINES

To enable Vickers diamond-pyramid hardness tests to be carried out on specimens which are too heavy or too bulky to be taken to the standard Vickers machine, Vickers Limited, Broadway, Westminster, London, S.W.1, have designed two portable testers which can be taken to the specimen and clamped in position. Both instruments are similar, one being a general-purpose tester, while the other is basically of the same design, but adapted for use on large gear wheels. The principle is that of the standard Vickers machine, in which an impression is made in the surface of a specimen by a diamond pyramid under pre-determined load and time conditions, the impression is measured across the diagonals through a microscope, and the readings are converted into standard V.P. numbers by means of a table. In the portable testers, however, the indenting load is applied hydraulically instead of by levers and dead weights. Two alternative indenting loads are available; 10 kg. or 30 kg. can be selected by means of a setting knob.

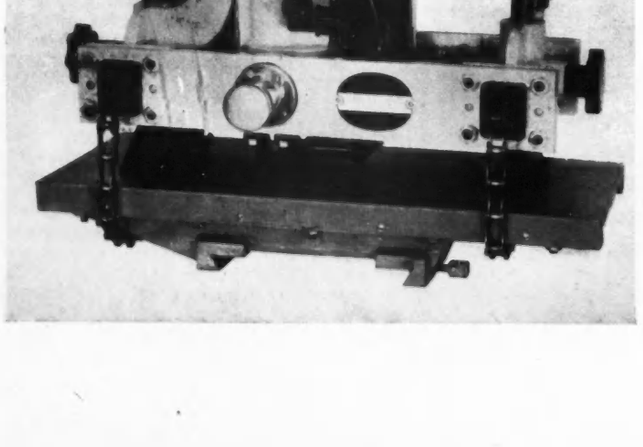
GENERAL-PURPOSE PORTABLE TESTER

The general-purpose tester, which is shown in the illustration below, consists of a body, with specially-shaped feet to rest on the specimen, an indenter unit and a microscope. The feet are of V-form, to rest on a flat or a curved specimen, and are adjustable for height so that the correct space can be set between the indenter and the specimen. They are carried in brackets, to which are attached two side plates. On the side plates are two pairs of steel hooks, a fixed pair on one side and an adjustable pair on the other. Two 1 in.-pitch roller chains are taken from the fixed hooks, round the specimen and back to the adjustable hooks, where they are pulled tight to clamp the tester in position. The indentor unit and microscope are mounted in between the side plates and are arranged to slide sideways so that the microscope can be brought over the impression after the load has been applied and withdrawn. Ball catches retain the indentor unit in either the working or the retracted position. The microscope, which is rigidly attached to the indentor unit, is fitted with a horizontal objective extension, which has the effect of bringing the objective to within 0·6 in. of the indentor; it is therefore only necessary to move the indentor unit and microscope through this distance to take a reading after applying a load. An operating handle is provided on top of the indentor unit and this, together with the body of the tester, side plates and foot brackets, is of light alloy construction. The hydraulic pistons are of toughened steel and work in bronze bushes. Plastic handwheels are used for adjusting the feet and for tightening the clamping chains. Guard strips are provided to protect the diamond in the event of the indentor being brought into contact with the specimen too heavily.

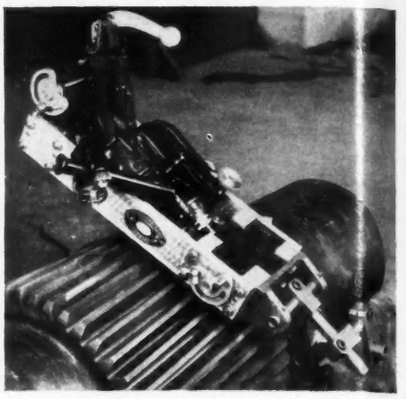
In operation the tester is placed in position on the specimen, the feet are adjusted to the correct height, and the clamping chains are tightened. The required indenting load is then set by means of a knob at the side of the indenting unit, and the operating handle is depressed to the full extent of its stroke. On release of the handle the tester applies the load automatically, holds it for approximately ten seconds, releases it, and withdraws the indentor clear of the specimen. The indentor unit and microscope are then moved over manually, and the impression is measured. Finally, the readings are converted into standard V.P. numbers by means of a table, in exactly the same way as with a standard machine.

HYDRAULIC LOAD APPLICATION

Reference to the appended diagram will show that the indentor is connected to a hydraulic piston and that the load is applied by a further piston under spring pressure. The indentor unit is filled with oil to a height indicated by *a*. To apply the load the operating handle *b* is depressed manually, so raising the load piston and compressing the spring *c*. This spring is capable of applying loads in excess of the rated capacity of the tester. As the piston moves, pressure inequalities open the non-return valve *d*, and oil passes from the exhaust space above the piston to the compression space below it. At the end of the stroke the pressures on both sides of the piston are equal, and the valve *d* is closed by its spring. There is a by-pass in the cylinder, but this port *e* is kept closed by the piston during the manual stroke.



The Vickers portable hardness tester applies a standard Vickers diamond-pyramid test with a load of 10 kg. or 30 kg. and can be clamped to a specimen of any size or shape.



For testing tooth-face hardness on large gear wheels the tester is made with an indentor set at an angle and fitted with a special clamp.

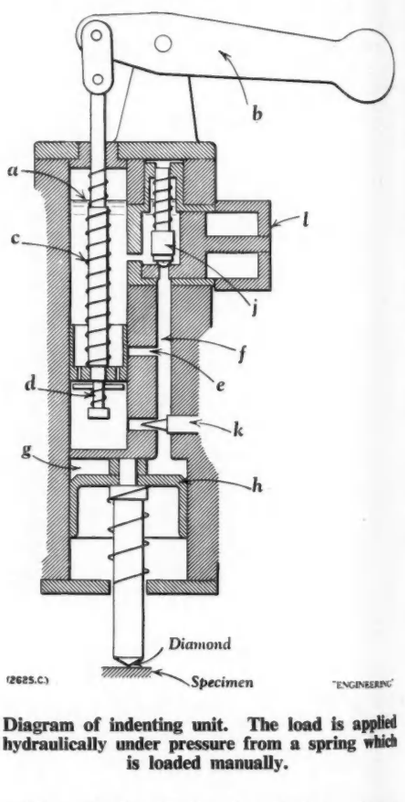


Diagram of indenting unit. The load is applied hydraulically under pressure from a spring which is loaded manually.

When the handle is released the spring *c* moves the piston downwards, and oil is forced into the load-valve chamber *f* and the indentor-operating cylinder *g*, causing the light spring below the piston *h* to be compressed, and the indentor to make contact with the specimen. Immediately contact is made the pressure builds up and the full indenting load is applied. The duration of the loading is determined by the needle-valve *k*, and the pressure by the release-valve *j*. The needle-valve is locked after initial setting to ensure constant load-timing conditions, but the release-valve *j* is provided with a rotary seating, turned by an external knob *l*, to enable either of the two indenting loads of 10 kg. or 30 kg. to be selected as required.

At the end of its stroke the load-applying piston uncovers the by-pass port *e*, and the oil flows into the exhaust space, relieving the pressure and allowing the indentor piston to be returned to its rest position by the spring. The indentor unit is now ready to be moved to bring the

microscope over the impression, and the load-applying piston is ready for the next indenting cycle.

APPLICATION TO LARGE GEARWHEELS

An adaptation of the general-purpose tester has been developed for testing on the pitch-line of large gears; this is shown in the illustration opposite. The basic principle remains the same, and the load is applied hydraulically, but the indentor cylinder and piston are set at an angle to the load-applying cylinder. This arrangement brings the indentor out at such an angle that it can apply the load directly on to the flank of a gear tooth. The indentor unit and microscope are carried in a bracket which is clamped to the gear and set at the correct angle to the tooth. Operation of the tester then proceeds in exactly the same way as with the general-purpose model.

PUMP FOR HYDRAULIC SYSTEMS

LIGHT-WEIGHT ELECTRIC UNIT FOR INTERMITTENT HIGH-PERFORMANCE DUTIES

An electrically-driven lightweight hydraulic pump of high-precision manufacture, with a high performance and the degree of reliability essential for the operation of powered flying controls in aircraft, has been introduced recently by Integral, Limited, Birmingham-road, Wolverhampton.

Designed to operate at pressures up to 4,000 lb. per square inch, the pump has a flow capacity of 0·42 gallons per minute at 6,500 r.p.m., and is available in two types—the Mark 1 for operation on a 200-volt three-phase 410-cycle supply (now in production for the flying-controls feel simulator of the Britannia aircraft), and the Mark 2, for operation on 24-volt direct current. The motor-pump unit was originally conceived as a source of emergency hydraulic pressure for power-operated flying controls, and in order to avoid recurrent stopping and starting of the electric motor, the latter is arranged to run continuously, the pump being designed to off-load when not answering pressure demands. The unit is equally suited to other similar duties.

The alternating-current motor for the Mark 1 version operates over the speed range 8,000-14,850 r.p.m. and is rated continuously at 0·75 h.p. The pump is flange-mounted on the motor, the drive to the internally-splined shaft of the pump being transmitted through a 3·78-to-1 reduction gearbox.

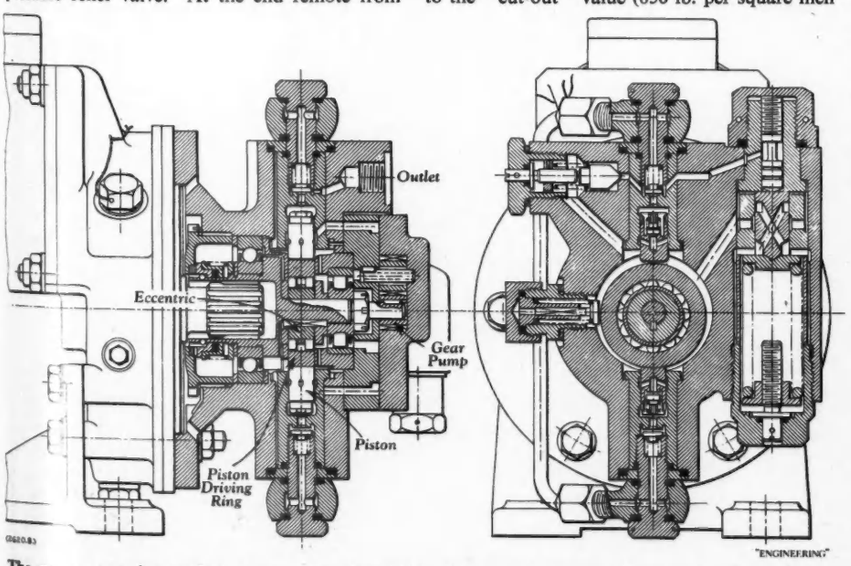
The pump itself is a two-stage unit comprising an eccentric-driven two-cylinder piston pump pre-charged by a small gear pump. Reference to the accompanying illustrations shows that the pump casing is in three sections—the main section, attached to the electric-motor gearbox mounting flange, housing the shaft bearings, the cylinder block, the delivery connection, the off-loading valve, and an adjustable delivery-pressure relief valve. At the end remote from the electric motor is the gear casing enclosing the idler and driven gears of the first-stage pump and housing the fluid inlet connection and a small " flow-evening " accumulator which also incorporates a gear-stage relief valve. Between the cylinder block and the gear casing is the transfer casing which houses one end of the idler gear shaft.

The pump shaft, of hardened steel, is carried in a ball thrust bearing at the inner end and a roller bearing at at the outer end of the cylinder block, and is sealed at the drive end by a spring-loaded carbon-ring type seal. An eccentric keyed to the shaft carries, on a two-row roller bearing, a piston driving ring. End float of the latter in both directions is limited by Meehanite thrust rings.

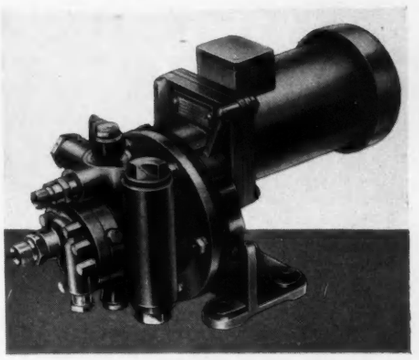
The pistons, which incorporate the fluid inlet valves, slide in hardened alloy-steel liners shrunk into the cylinder block, the delivery valves being situated at the outer ends of the liners. Both inlet and delivery valves are of the spring-loaded disc type.

The action of the pump is as follows: the gear pump delivers fluid under pressure through ducts in the transfer block into an annular duct surrounding each cylinder sleeve. At low altitude the gear pump delivery is greater than the piston pump requires, and the excess delivery serves to charge the flow-evening accumulator, surplus fluid being passed back to the inlet through relief ports in the accumulator cylinder uncovered by the accumulator piston. By this means an even flow is available to the piston pump up to high altitudes without the necessity for pressurising the fluid reservoir.

The piston-pump delivery is led to an external accumulator. When the line pressure has risen to the " cut-out " value (850 lb. per square inch on the Mark 1 motor-pump unit) at which the off-loading valve is set, the latter will open, allowing the gear-pump delivery to bypass the piston pump and return to the gear-pump inlet, the pressure then being insufficient to open the piston inlet valve. The piston delivery valves will then be kept closed by the accumulator pressure, and the pistons will remain stationary clear of the driving ring, the latter being prevented from spinning under these conditions by a spring-loaded rotor brake. The electric motor and pump shaft continue to run while the pump is unloaded. When the line pressure falls again to the " cut-in " value (650 lb. per square inch on the Mark 1 unit) the off-loading valve will close, directing pressure to the piston inlet valves so that the pump commences delivery again.



The pump comprises a first-stage gear pump with a flow-evening accumulator and a second-stage eccentric-driven two-cylinder piston pump.



In the Integral electrically-driven hydraulic-pump unit, the motor runs continuously and the pump, designed for 4,000-lb. per square inch systems, is off-loaded when not answering pressure demands.

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AUTOMATIC CHARGING OF NICKEL-IRON BATTERIES

The charging of lead-acid secondary batteries can be controlled by utilising the voltage rise which takes place during the operation to actuate a time switch, and thus to cut off the current after a suitable interval. This arrangement is, however, less desirable in the case of nickel-iron batteries in which the voltage rise is less and not so sudden. In addition, a nickel-iron battery must either be continuously charged at its rated discharge current or the average current during charge must not exceed this value. If this procedure is not followed, overheating due to excess current, or reduced performance due to a deficiency in the current may occur.

To overcome this difficulty Mr. E. R. Constance, chief engineer of Harrods, Limited, has devised a system which is being used on the 60-cell nickel-iron batteries with which the 34 electric vans comprising the firm's fleet are equipped. These batteries have a normal charging rate of 45 amperes, which is controlled by two direct-current meters and two time switches manufactured by Chamberlain and Hookham, Limited, New Bartholomew-street, Birmingham.

One of these meters is arranged to open the charging circuit as soon as the charge allocated to a given period has been supplied. At the same time it records the total charge that has been given to a battery during its life. The second meter controls the total amount of the charge and also opens the circuit on its completion. One of the time switches is adjusted so that only 22·5 amperes can pass into the battery every half hour, while the other determines the time at which charging is to begin. This switch can also be used to terminate the charge should any of the contacts fail. The other time switch controls the start of the charge and is adjusted so that charging is completed at the moment the van has to start out.

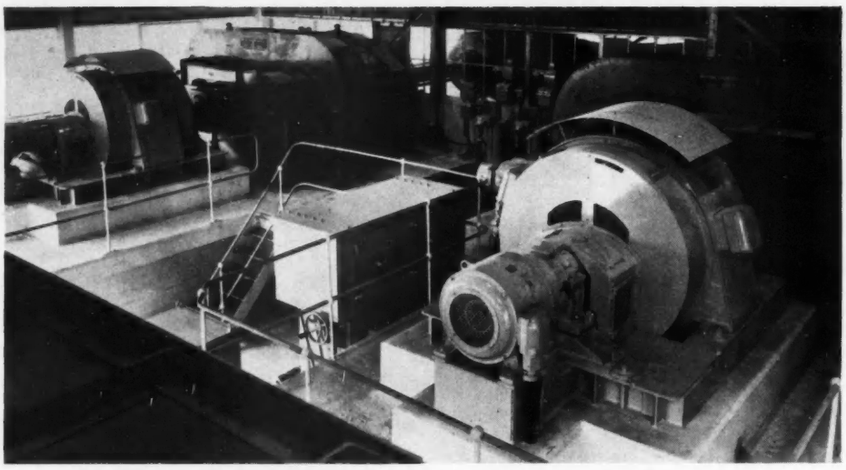

Fig. 1 Two units as installed at the cement works.

REDUCTION GEARS FOR BALL MILLS

COAXIAL DRIVE USED IN CEMENT WORKS

Coaxial reduction gears for driving ball mills were developed in Sweden some years ago and were later used in mine winder drives with motor and gearbox mounted on the top of the head gear. These drives used divided lay shafts and, having balanced bearing reactions, are very stable. Similar types of drive have been used in Naval vessels both in America and in this country. From their Admiralty design, the British Thomson-Houston Company, Limited, Rugby, have developed a compact double reduction coaxial gearbox for a cement ball mill, using double-helical gears. The particulars given here are obtained from an article on the subject which is to appear in the Company's house journal.

The gearbox that has been designed is shown in Fig. 3. It is intended to transmit 1,200 h.p. with a speed reduction from 750 r.p.m. to 20·5 r.p.m. and has, in addition, a barring motor for rotating the mill very slowly when inspection or repairs are to be carried out.

The similarity of arrangement of pinions and wheels to the earlier ship propulsion design will be clear from the illustration. Although the principles of operation of the twin-drive gearbox are similar whatever the nature of the drive, the application to any particular case may necessitate certain modifications. This is particularly true both with regard to the coupling of the driving motor or turbine to the gear pinion, and to the coupling of the driven unit.

The action of the loose heavy balls inside the mill drum continually cascading on to cement clinker gives the drive certain vibrational tendencies together with a varying rotational sideways movement. The drum rests on two cradle bearings and when these wear, movement can be as much as $\frac{1}{8}$ in. off centre. These difficulties dictate the need for a special flexible link between the mill coupling and the gearbox coupling, particularly if the gearbox is rigidly bolted to foundations.

To obtain this necessary flexibility between the mill drum shaft and the gear low-speed shaft in the gearbox illustrated, two specially-developed bonded-rubber bush couplings were used, one on each end of a torque shaft 11 ft. long. The mill end of the torque shaft and flexible coupling are illustrated in Fig. 2. This coupling was designed to accommodate an axial movement of $\frac{3}{8}$ in. and a radial displacement of $\frac{1}{4}$ in. without imposing additional loads on the gear-box low-speed wheel and bearings. It will also accommodate an out-of-alignment deflection equivalent to one degree at coupling face at either end of the torque shaft. The capacity of the coupling under normal load is equivalent to an h.p./r.p.m. ratio of 60, and it is believed to be the first time that this type of coupling arrangement has been used for such a heavy duty.

BARRING MOTOR AND GEAR

Inside the tube mill are a large number of lining plates upon which the balls cascade during rotation in order to grind the cement clinker. The grinding action between the balls and the plates necessitates attention to, and renewal of, these parts, and another required feature of the gearbox design is to be able to rotate the mill at very low speeds, the case under consideration being as low as 1 r.p.m. A barring motor has, therefore, been incorporated in the gearbox and can be seen in the foreground of Fig. 3.

The barring motor engages with the first drive pinion through gearing and a ratchet type of coupling with centrifugally-operated pawls. The arrangement permits the alternative barring or main drive to be automatic and self-controlling. The barring motor is started by push-button and the main motor can be switched on as required, entirely independent of the barring arrangements. When the main motor reaches a predetermined speed, the pawls automatically disengage the barring motor driving shaft. The arrangement eliminates the need for any hand clutches, and is a convenient asset to the operation of a cement grinding mill drum. It is believed also that this is the first time that this barring arrangement has been applied to the manufacture of cement.

Fig. 1 shows the motor house with two of the complete units installed. The main motors run at 750 r.p.m. and the mills at 20·5 r.p.m. approximately. The barring motor speed is 1,450 r.p.m. with a total barring and main gear ratio of 1,450/$\frac{3}{8}$ r.p.m.

MACHINING OF GEAR TEETH

The teeth were cut in the steel forgings under temperature-controlled conditions, and have the precision of accuracy usually associated with high-speed turbine drives. The load on the teeth in lb. per inch of axial length is equivalent to a "K" factor of 133, derived from the formula:—

$$\frac{\text{lb. per inch}}{\text{P.C. diameter}} \times \frac{(R+1)}{R}, \text{ where } R = \text{gear ratio.}$$

It is important to have both external and internal flexibly-coupled shafts to safeguard the teeth against shock loads, to maintain the original accuracy of cutting and assembly.

The difficulties peculiar to ball-mill operation, as already described, tend to induce gear designers to favour gears of relatively coarse pitch, precision being sacrificed as a consequence; but no such limitations are imposed on the gear designer with the manufacturing resources of a shop equipped with modern gear-cutting machines and proper facilities for quality control.

The difference in operation of the new gearbox

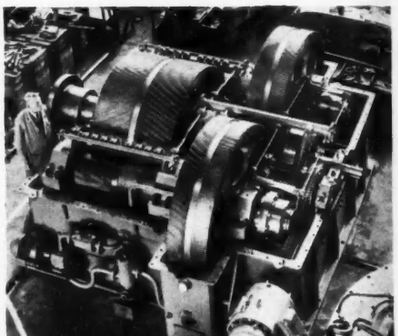

Fig. 3 Coaxial drive gearbox transmitting 1,200 h.p. through a ratio of 750 r.p.m. to 20·5 r.p.m. A barring motor is fitted to give a mill speed of 0·625 r.p.m.

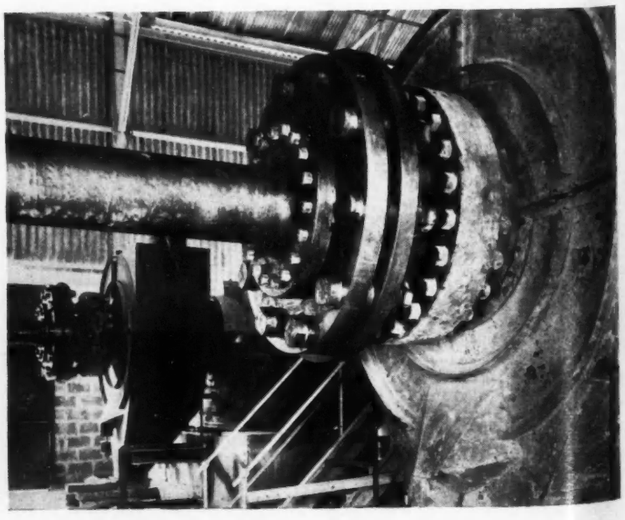

Fig. 2 Flexible coupling in the drive shaft. With a h.p./r.p.m. ratio of 60, it will allow $\frac{3}{8}$-in. axial movement and $\frac{1}{4}$-in. radial displacement.

under load, compared with that of an older design running alongside, was most marked; there being a complete absence of noise or vibration from the new gears. A check of pitch inaccuracies and their effect on the operation of the box was made on site. Pitch-to-pitch errors resulted in a measured disturbing acceleration force axially of only one sixth of the normal full-load torque. A check was also made of the load sharing, the result being 49/51 per cent. for each limb of the drive.

It is believed that a further improvement in design and a better performance would result from the use of a combined baseplate for the motor and the gear-box, thus facilitating erection on site and contributing further towards an assured continuous alignment between the motor and the outgoing shaft of the gear-wheel. However, this would be largely a matter of economics.

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SIDE LAUNCHING

Diesel Trawlers for "Near-water" Fishing

The sixth and last paper in the programme of the Autumn Meeting of the Institution of Naval Architects, which was summarised, with the discussion, in ENGINEERING, of November 19 last (vol. 178, page 655, 1954), dealt with "Side Launching of Ships, with Special Reference to Trawlers," and described experimental work carried out by the Ship Division of the National Physical Laboratory at the instigation of Messrs. Cook, Welton and Gemmell, Limited, at whose shipyard in Beverley, Yorkshire, this is the customary method of putting ships into the water. By the courtesy of the builders, we were enabled to see the method in practice on December 11, when they launched the trawler Princess Anne, the first of the Diesel-driven vessels which they have on order for the St. Andrews Steam Fishing Company, Limited, Hull, and the Boston Deep Sea Fishing and Ice Company, Limited, of Fleetwood. The ships are being built in accordance with the terms of the White Fish Authority's scheme for encouraging the modernisation of the British fishing fleet. The launching is shown in the illustration below.

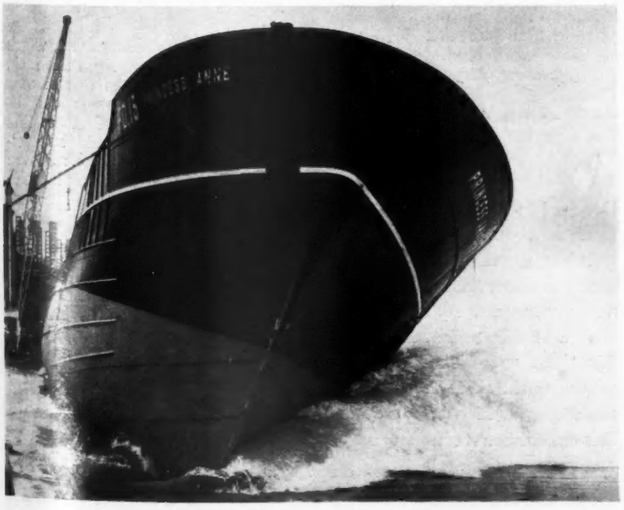
The Princess Anne has a length overall of 152 ft. 3 in., but the "registered length" is 139 ft. 9 in., in compliance with the requirements of the scheme. The breadth moulded is 28 ft. and the moulded depth, 13 ft. 9 in. The gross tonnage will be about 390. The vessel has been designed for what is termed "near-water" fishing, i.e., in home waters, where the sea conditions can be severe for craft of such comparatively small size. She has been provided, therefore, with high bulwarks extending from the after end of the deckhouse to the enclosed topgallant forecastle, and a pronounced flare forward to the "soft-nose" stem. The form of the hull, and also the design of the propeller, have been based on model tests made at the National Physical Laboratory, Teddington. Accommodation for the complement of 20 is arranged amidship and aft, with fully protected access to the bridge.

The fishroom has a capacity of 9,300 cub. ft. It is insulated and wood-lined, and is subdivided into pounds for the various types and qualities of fish. The fishroom stanchions and the angles supporting the shelves are of aluminium alloy, and there is provision for fitting close-spaced cod shelving. Tanks for the carriage of fish livers are arranged forward of the fishroom, and under it is a double-bottom tank for water ballast. Fresh water is carried in tanks in way of the shaft tunnel, and fuel for the main engine, to a total quantity of 86 tons, in the double bottom and in side bunkers. There is a separate 5-ton tank for gas oil. Gauges in the engine room indicate the contents of the fuel tanks which are so disposed as to form the supporting structure for the heavy Diesel-driven generator for the electric trawl-winch.

The main propelling engine is being supplied by British Polar Engines, Limited, Glasgow, and is of their M46M type, developing about 850 h.p. at 250 r.p.m. It will be installed, with the other machinery, by Amos and Smith, Limited, Hull. A Mirrlees TL6 Diesel engine of 305 brake horse-power will drive the Robertson-Laurence Scott trawl winch, which is equipped with an electric motor of 280 h.p. and Ward-Leonard control gear. An auxiliary Diesel engine of their E3 type has been supplied by Russell, Newbery and Company, Limited, Essex Works, Dagenham, to drive a 30-kW generator, a Hamworthy N2G air compressor and a centrifugal pump. The Hamworthy Engineering Company, Limited, Poole, Dorset, are also the contractors for the independent electric general-service and fresh-water pumps, and the lubricating-oil pump. Other auxiliaries include an Alfa-Laval lubricating-oil purifier fitted with a 4-kW electric heater, a cold-starting Lister engine driving a Distar air compressor, and a Mono pump for oil-fuel transfer duties. The electric lighting system will be installed throughout by William Broady and Son, Limited, Hull, and will operate on direct current at 220 volts. There are three available sources of supply, namely, the Diesel-driven auxiliary generator, a generator driven from the shaft of the main engine, and the winch exciter generator; all are of 30 kW capacity. The four-bladed solid propeller is being supplied by J. Stone and Company, Limited, Deptford.

The deck and navigating equipment includes an electric windlass, supplied by Reid and Sons (Paisley), Limited, an electro-hydraulic steering gear (which can be operated also by hand) by Donkin and Company, Limited, a Marconi wireless and radio-telephone installation, radar, and a Seagraph echo-sounder. Marconi sound-reproduction equipment is also being fitted. The two lifeboats are carried on the boat deck aft, under Welin-Maclachlan davits.

The vessel was named Princess Anne by Mrs. L. G. Eyles, assistant mistress at West Newton school, on the Royal estate at Sandringham, this school having "adopted" the vessel under the arrangements sponsored by the Ship Adoption Society.



The trawler Princess Anne being launched at Beverley. Side launching is the custom at this yard.

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TESTS ON A 3,500-MVA 132-kV CIRCUIT BREAKER

Exhaustive tests have recently been carried out in the High Power Testing Laboratory of the General Electric Company, Limited, at Witton, Birmingham, on a new design of circuit-breaker with a rupturing capacity of 3,500 MVA at 132 kV. These tests included breaking the transformer magnetising current, or shunt reactor current, at 20, 50 and 100 amperes at the rated voltage, six operations being carried out at each current. The single-phase tests at 114 kV comprised three breaking operations at 5 per cent., 10 per cent. and 30 per cent. of the rated breaking current of 15·3 kiloamperes and two make-break operations at 50 per cent. of the rated breaking current.

The three-phase tests on a complete breaker consisted of three breaking operations at 60 per cent. of the rated symmetrical breaking current and 66 kV; two make-break operations at 100 per cent. of the rated symmetrical breaking current and 38 kV; three breaking operations at 100 per cent. of the rated symmetrical current and 38 kV; and three breaking operations at 100 per cent. of the asymmetrical breaking current and 38 kV.

Three-phase tests were also made on a single phase using Biermans' circuit, in which a flexible lead is attached to the moving contact and the three phases of the testing circuit are connected to this lead and the terminals of the breaker pole respectively. With this arrangement three breaking operations were carried out at 60 per cent. of the rated breaking current and 67 kV per break; three breaking operations at 100 per cent. of the rated symmetrical breaking current and 33 kV per break; and three breaking operations at 100 per cent. of the rated asymmetrical breaking current and 33 kV per break.

The single-phase tests on a single break of one pole included three breaking operations at 100 per cent. of the rated symmetrical breaking current and 57 kV; and three breaking operations at 100 per cent. of the rated asymmetrical current at the same voltage.

We understand that the results of all these tests were satisfactory and that a certificate of breaking capacity is being issued by the Association of Short-Circuit Testing Authorities.

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ROCK-TUNNELLING RECORD CLAIMED

During a recent seven-day period on the St. Fillans section of the Breadalbane project of the North of Scotland Hydro-Electric Board, a tunnel of 10 ft. 6 in. diameter was driven 428 ft. through a hard epidiorite rock—a rate of progress which is claimed to be a European tunnelling record. The rock spoil, weighing about 1,400 tons, was loaded out using a No. 21 Rockershovel made by Eimco (Great Britain), Limited, Piccadilly, London, W.1.

Work under cover was begun in August and, up to mid-December, 8,500 ft. of various diameters had been driven on the several working faces. The contractors at the site are the Mitchell Engineering Group, Limited, Bedford-square, London, W.C.1, and the consultants Sir Murdock MacDonald and Partners, 72 Victoria-street, Westminster, S.W.1.

" Silo-aid " designed for cutting peat and silage. It can also be used for farmyard manure, and versions fitted with an 80-c.c. petrol engine or a ½-h.p. electric motor are made.

MECHANICAL CUTTER

Designed for Peat and Silage

Cutting peat or silage by hand is an arduous and time-consuming job. A machine to make the job much easier and quicker has been designed by Atkinson's Agricultural Appliances, Limited, Clitheroe, Lancashire, and is called the " Silo-aid." As shown in the illustration above, it consists of an oscillating blade driven by a small motor. The full depth of the blade is 8 in., and when it has reached full depth a slight rocking movement by the operator causes the machine to inch along in the direction of the desired cut. The tool is designed to cut a straight face and square corner and on test has cut to the full depth of 8 in. at the rate of 12 ft. per minute. It can also be used for cutting farmyard manure, and for this purpose a special blade has been designed as an optional extra.

The motor for the Silo-aid can be either an 80-c.c. JAP petrol engine or a ½-h.p. electric motor. The petrol engine is fitted to the model P silo-aid, which has a total weight of 47 lb., and a fuel tank of 3-pints capacity. The electric motor is supplied with model E; it is a ½-h.p. split-phase alternating-current motor, which has an on/off switch on the handle, and is protected from over-load by a trip device which can be reset from the operating position. The voltage range is from 200 volts to 250 volts on 50-cycles alternating current, and the total weight of the cutter is 47 lb.

METAL-BACKED NYLON BEARINGS

No Lubrication at Low Temperatures

A high-precision sleeve-type bearing comprising a specially designed metal shell into which is moulded a nylon lining about 0·005 in. thick, rigidly anchored to the outer shell, has been developed by the Nylacore Corporation, 305 East Shore-road, Great Neck, New York, U.S.A. These bearings can, if desired, be supplied with thrust facings, oil seal and dust-protecting rings on either end, or with one end closed. They are available in a range of sizes from ⅛-in. bore and lengths of 0·04 in. upwards, accurate to within ± 0·0001 in. on outside diameter, 0·0002 in. on bore, 0·0005 in. on length, and ± 0·0005 in. on concentricity.

At temperatures up to 200-230 deg. F. no lubrication is required for continuous operation although for optimum bearing life the manufacturers recommend that the bearing temperature should not exceed 75 deg. to 100 deg. F. Should operating temperatures exceed 230 deg. F., means should be provided to supply oil, grease or some other coolant to the bearing. At low temperatures down to — 100 deg. F., Nylacore bearings require no lubrication. These bearings are, moreover, chemically inert.

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TWO-ROLL CIRCLING MACHINE

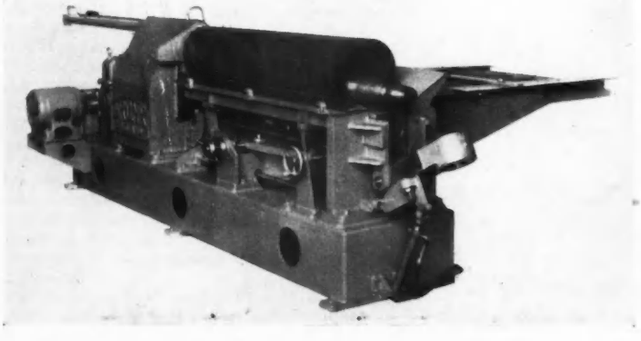
Forming Bar Reduces " Flat "

The illustration below shows a single-pass circling machine which has been designed by the Bronx Engineering Company, Limited, Lye, Stourbridge, Gloucester, to roll cylindrical drums from flat sheet steel. It consists of one pair of high-carbon steel pinch rolls which, assisted by the air-operated feed table, grips the sheet and forces it forward against the forming bar. This bar has been designed for working close to the rolls so that only a very small flat remains on the finally rolled sheet. It is claimed that, within the capacity of the machine, flat sheets can be transformed into cylinders at a single pass and without manual work other than placing the sheets on to the feed table. The maximum length of cylinder accommodated is 5 ft.

The machine is equipped witha 4-h.p. squirrel-cage motor, the drive being transmitted to the rolls through steel gears mounted in the main housings and lubricated constantly from an oil bath. The position of the bottom roll can be adjusted to suit the thickness of the material (maximum gauge: 10) and, as may be seen from the illustration, the off-side end bearing of the top roll can be swung clear to permit removal of the finished cylinder. Movement of the bearing is controlled by an air cylinder, and the rolled sheet is ejected from the machine on to a receiving table or conveyer (provided by the user) by an air pusher.

The forming bar is operated by toggle levers actuated by air cylinders, so that the bar can be dropped to release the work and then returned to its normal working position, which can be adjusted to suit the gauge of sheet and the cylinder diameter required.

All the air valves are foot operated and the several pedals are conveniently grouped on a floorplate which can be located to suit the user's requirements. The machine is completed fully equipped and ready to be connected to the mains air line; a pressure of 80 lb. per square inch is required.



Designed for rolling light-gauge sheet into cylinders up to 5 ft. long, the Bronx circling machine has two rolls and a forming bar. The " flat " remaining on the rolled sheet is small compared with that obtained on a conventional three-roll machine.

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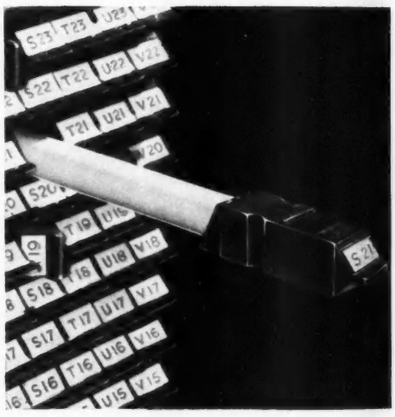
STORING DRAWINGS

System Allowing Quick Reference and Reducing Damage

The storage of large numbers of drawings in such a way as to make reference easy is a problem which most firms have had to face, and several solutions have been offered. Now James H. Randall and Son, Limited, Paddington Green Works, London, W.2, are making available their " Planstore " equipment for this purpose. It is claimed that this equipment enables a very large number of drawings to be stored on a small ground space while permitting any one to be located and removed very quickly.

Basically, the equipment consists of a rack in which the rolled drawings are stored horizontally. The end of each drawing roll is inserted in a plastic " handle " which forms a sealing plug when pushed into the rack. This handle can be seen in the accompanying illustration, which shows a drawing partly removed from the rack. The visible end of the handle has two sloping surfaces on which identity numbers can be marked. The suggested method of use is that normally these identity marks should be horizontal, but that when a drawing has been removed for reference, a location slip should be placed in the socket and the handle replaced in the rack with the identity numbers vertical to indicate that the drawing is in use.



A rolled drawing is inserted into a socket in the plastic handle shown, which itself acts as a seal to the compartment.

Racks are made for double-elephant (27 in. deep) or antiquarian (29½ in. deep) drawings, both types being 37 in. wide. Three sizes of each are available, either 34, 46, or 89 in. high. The largest has 1,188 compartments. Where drawings are being stored for record, as many as five can be inserted in the same socket enabling almost 6,000 drawings to be stored on a ground area of approximately 9 sq. ft. It is claimed that with this equipment the drawings cannot be easily damaged and those which have already been damaged at the ends can be protected by paper sleeves.

Labour Notes

RAILWAY WAGE DISPUTE

Up to the time of going to press, little progress appeared to have been made towards solving the problem presented by the threat of the National Union of Railwaymen to take strike action, as from midnight on Sunday next, unless the balance of its claim for a 15 per cent. increase in wages were granted in full.

The only ray of hope seemed to lie in the promise of the court of inquiry, set up by the Minister of Labour, Sir Walter Monckton, on December 24, that they would present an interim report to the Minister about the middle of this week, and that its contents will form the basis for a renewal of negotiations between the two sides.

Sir John Cameron, Q.C., was appointed chairman of the court; the other members being Sir Colin Anderson, a vice-president of the British Employers' Confederation, and Mr. Harry Douglass, general secretary of the Iron and Steel Trades Confederation and a member of the Trades Union Congress General Council. Their terms of reference were " to inquire into the causes and circumstances of the dispute and to report."

Although recommendations put forward by courts of inquiry are not binding on either side to a dispute, their suggestions have, in the past, almost invariably paved the way for a settlement. Unlike arbitration tribunals and similar bodies, courts of inquiry have the advantage of being able to examine past negotiations and disputes in the industry concerned, and to make suggestions on the merits of the cases presented to them, instead of being restricted to the precise terms of a specified claim.

DESIRE FOR " A SQUARE DEAL "

Although the executive committee of the N.U.R. declined a further appeal from Sir Walter to call off their preparations for a national strike, they agreed to co-operate with the court of inquiry.

The men's case was accordingly presented at a public sitting of the court on December 30, when Mr. J. Campbell, the union's general secretary, submitted that the railwaymen's case was such as to amply justify the decision to strike. He pointed out that the last railway strike of a national character had taken place 35 years ago and that the resolve to break that record had not been taken lightly.

After 17 months of negotiations, on which great hopes were placed, railway wages were still unreasonably low. There was very general recognition that these rates of pay were inadequate in an industry of such great importance to the nation and the British Transport Commission had often expressed a wish to be able to pay higher wages.

The union's executive committee had reluctantly concluded that no other way was open to them to secure justice for men who had waited so long for " a square deal " than by giving notice to strike.

CRITICISM OF COST-OF-LIVING INDEX

An application for an all-round increase in wages of 15 per cent. was first presented in July, 1953, and Mr. Campbell outlined the negotiations which followed. He referred to the settlement reached on December 16, 1953, by which the Commission had undertaken to examine with the unions the whole of the industry's wages and salary structure.

Subsequently, the two sides encountered serious difficulties over that undertaking, which had raised such high expectations among railway employees. Hopes for a wage structure worthy of the industry receded and it became an exhausting matter to obtain a concession for an extra shilling or so.

When the terms of the settlement of October, 1954, to which the union's executive committee had consented with reluctance, became known, there was widespread revolt among rank-and-file members, owing to the meagre concessions granted. These ranged only from 4*s.* to 8*s.* 6*d.* a week, with but 6*d.* a week more for many starting grades.

Before the war, Mr. Campbell contended, security of employment was some compensation for very low wages, but such security did not possess the same value during periods of full employment. At the present time, large numbers of railwaymen were leaving the industry in order to take up better-paid and more attractive employment elsewhere. As a result, standards of efficiency on the railways were likely to degenerate rapidly if the process continued.

He suggested that, had the application for an advance of 15 per cent. been granted in full in July, 1953, it would have done no more than maintain the modest standard of wages paid in 1947. Since that year, in which the revised interim index of retail prices had been introduced, railwaymen's wages had failed to keep pace with the cost of living.

The official cost-of-living figure had become no more than a mockery to the ordinary working-class family. The union contended that the index was, in fact, far from a reliable guide.

RAILWAYS A COMPETITIVE INDUSTRY

The general secretary of the Associated Society of Locomotive Engineers and Firemen, Mr. J. G. Baty, said that his union had been a party to the original application for a 15 per cent. increase. The union ultimately took its claim to the Railway Staff National Tribunal because it considered that the locomotive men had had by far the most unfavourable treatment.

On behalf of the Transport Salaried Staffs' Association, it was stated that that union was not intervening because it was at present in negotiation with the Commission, but that did not mean that its members were not restive.

Replying on behalf of the British Transport Commission, Mr. W. P. Allen, the labour-relations member, stated that the Commission did not agree that there had been a delay of 17 months. The alternative to strike action was to take the claim to the Railway Staff National Tribunal. The Commission wanted its staff to receive decent rates of pay, but was bound by what it could reasonably be expected to do. The estimated cost of the various concessions arising from the agreement of December, 1953, amounted to more than £22 million a year.

The industry was a competitive one. Fares and freights could not be raised without regard to the charges of other forms of transport and the operating costs of undertakings which ran their own road-haulage vehicles. There was a real danger that many of the Commission's services might be priced out of the market.

MOTOR-CAR FACTORY DISPUTE

In all, about 11,000 employees of the Standard Motor Company, Limited, at factories in Coventry, became involved in an unofficial dispute which commenced on December 30, as a result of the dismissal of four shop stewards from the company's service.

The management of the company stated that the firm would not negotiate on the question of the dismissals, but that discussions on the reinstatement of nine other employees who had been dismissed could take place as soon as there was a full resumption of work.

The trouble appears to have arisen out of " a series of incidents," some of which occurred on Christmas eve. Nine men employed in the spare-parts department at the firm's factory at Maudslay-road, Coventry, were indefinitely suspended, owing to their alleged refusal to handle work which they stated was the subject of dispute.

The dismissal of the shop stewards seems to have taken place as the result of meetings being called, apparently during working hours, without the approval of the management.

It was stated by the firm, in an official notice, that the company had no dispute with the trade unions, as it recognised the work of these bodies at its factories. At the same time, the company felt bound to establish the principle that it had the right to manage its own works, and that, when decisions were made by the firm's management, they had to be observed.

It was further pointed out that there had been occasions when instructions from the management had been disregarded, in spite of prior warnings being given by the firm's representatives to shop stewards.

Prompt efforts were made by local officials of the unions to settle the difficulty, and discussions with the company's representatives followed. These resulted in a mass meeting of strikers on Monday last, at which a resolution to accept compromise proposals and to return to work was carried.

FEWER BOYS APPRENTICED TO ENGINEERING TRADES

According to statistics compiled by the Ministry of Labour and National Service, fewer boys entered the engineering, shipbuilding, and electrical-goods industries as apprentices during 1953, than during the preceding year.

The official figures show that 23,620 boys aged between 15 and 17 years were apprenticed in that group of industries in 1953, compared with 24,030 in 1952, a decline of 410. There was also a decline, from 44,600 in 1952 to 42,800 in 1953, in the numbers of boys apprenticed in the metals and metal-using industries.

On the other hand, boy apprentices entering the building and contracting industries increased from 19,500 to 21,200 during the twelve months.

WAGE CLAIM

Demands by the Confederation of Shipbuilding and Engineering Unions for improvements in wages in the engineering industry were discussed by the board of management of the Engineering and Allied Employers' National Federation in London on December 30.

It was decided to adjourn the discussion until the board's next meeting, on January 27, when it is hoped that the views of individual firms on the unions' proposals will be available. A final opinion on the claims can then be taken and this decision is expected to be communicated to representatives of the Confederation about the middle of next month.

The claims were presented to the employers' Federation on December 14 last. The principal concessions sought were wage increases of 15*s.* a week for craftsmen and 10*s.* a week for labourers. In addition, the Confederation is seeking to improve the wage structure throughout the industry and, with this end in view, is asking for the formation of three or four intermediate grades, with minimum wage rates for each, to provide for the constantly widening groups of employees who have acquired a certain amount of skill owing to developments in mechanisation.

NOTICES OF MEETINGS

British Institution of Radio Engineers

GLASGOW
Discussion on "Channel III Commercial Television." Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., Jan. 13, 7 p.m.
NEWCASTLE-UPON-TYNE
Address by the President of the Institution, Rear-Admiral (L) Sir Philip Clarke. North-Eastern Section. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Wed., Jan. 12, 6 p.m.
TREFOREST
"Electronic Counting Devices," by Dr. F. H. Gage. South Wales Section. Glamorgan Technical College, Treforest. Wed., Jan. 12, 6.30 p.m.
WOLVERHAMPTON
"Electronics in Materials Handling," by L. Landon Goodman. West Midlands Section. Wolverhampton and Staffordshire Technical College, Wulfruna-street, Wolverhampton. Wed., Jan. 12, 7.15 p.m.

Chemical Society

BIRMINGHAM
"The Structures of Electron-Deficient Substances," by Professor H. C. Longuet-Higgins. Birmingham Branch. Chemistry Department, The University, Birmingham. Fri., Jan. 14, 4.30 p.m.
EDINBURGH
"Organic Inclusion Compounds," by Professor W. Baker. Edinburgh Branch. North British Station Hotel, Edinburgh. Thurs., Jan. 13, 7.30 p.m.
PORTSMOUTH
"Fission Products," by P. E. Carter. Southampton Branch. Municipal College, Anglesea-road, Portsmouth. Fri., Jan. 14, 7 p.m.

Illuminating Engineering Society

LONDON
"Fading and Related Effects Associated with Radiation from Light Sources," by B. S. Cooper. Royal Society of Arts, John Adam-street, W.C.2. Tues., Jan. 11, 6 p.m.

Incorporated Plant Engineers

DUNDEE
"Fans and Fan Engineering," by C. J. Atkins. Dundee Branch. Mathers Hotel, Dundee. Mon., Jan. 10, 7.30 p.m.
EDINBURGH
"Aspects of Fire Prevention," by A. Dunn. Edinburgh Branch. 25 Charlotte-square, Edinburgh. Tues., Jan. 11, 7 p.m.
LEICESTER
"Fans and Air Conditioning and Axial-Flow Fans," by R. H. Holbeche. Leicester Branch. Leicester College of Art and Technology, The Newarkes, Leicester. Wed., Jan. 12, 6.30 p.m.
MANCHESTER
"Pulversied Coal Firing for Lancashire Boilers," by V. Taylor. Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., Jan. 11, 7.15 p.m.
NEWCASTLE-UPON-TYNE
Three short papers by branch members. North-East Branch. Roadway House, Oxford-street, Newcastle-upon-Tyne. Thurs., Jan. 13, 7 p.m.
NOTTINGHAM
"Gas Turbines Applied to Traction Vehicles," by P. A. Phillips. East Midlands Branch. Adult Education Centre, Shakespeare-street, Nottingham. Wed., Jan. 12, 7 p.m.

Institute of British Foundrymen

BEDFORD
"Production of Castings for Diesel Engines," with film, by C. R. van der Ben and H. Haynes. Bedfordshire and Hertfordshire Section. Works of W. H. Allen, Sons & Co., Ltd., Bedford. Thurs., Jan. 13, 7.30 p.m.
LINCOLN
"A Mechanised Foundry for Small Blackheart Malleable Castings," by J. Roxburgh. Lincolnshire Branch. Technical College, Lincoln. Thurs., Jan. 13, 7.15 p.m.
SOUTHAMPTON
Film Evening. Southampton Section. Technical College, St. Mary's-street, Southampton. Thurs., Jan. 13, 7.30 p.m.
THORNABY-ON-TEES
"Shell Moulding", by J. Alcock. Tees-Side Branch. Offices of Head, Wrightson & Co., Ltd., Teesdale Hall, Thornaby-on-Tees. Fri., Jan. 14, 7.30 p.m.

Institute of Fuel

LONDON
"Integration in the Iron and Steel Industry," by W. F. Cartwright. Institution of Civil Engineers, Great George-street, S.W.1. Thurs., Jan. 13, 5.30 p.m.
MANCHESTER
Papers on "Sulphur Removal and Recovery Within the Gas Industry," by Dr. R. H. Griffith and others. North-Western Section. Engineers' Club, Albert-square, Manchester. Fri., Jan. 14, 2.15 p.m. Preceded by members' luncheon at 1 p.m.
NEWCASTLE-UPON-TYNE
"Carbonisation of Blends of Coal to Produce Metallurgical Coke," by H. Bardgett. North-Eastern Section. King's College, Newcastle-upon-Tyne. Mon., Jan. 10, 6.30 p.m.
NOTTINGHAM
Film Evening. East Midland Section. Gas Board's Showrooms, Nottingham. Wed., Jan. 12, 6.15 p.m.

Institute of Marine Engineers

LONDON
"Non-Metallic New Materials in Engineering," by Dr. N. J. L. Megson. Tues., Jan. 11, 5.30 p.m.
CARDIFF
"Marine Closed-Feed Systems," by D. C. Hagen. South Wales Section. Junior Lecture. Cardiff Technical College, Cardiff. Wed., Jan. 12, 7.15 p.m.
GLASGOW
"Ship and Machinery Trials," by G. E. Barr. Scottish Section. Student Lecture. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow. Fri., Jan. 14, 7.30 p. n.

Institute of Petroleum

LONDON
"Insurance in the Oil Industry," by A. T. Wright. Wed., Jan. 12, 5.30 p.m.

Institute of Road Transport Engineers

BIRMINGHAM
"The Application of Rubber Bonding to Commercial Vehicles," by A. J. Hirst. Midlands Centre. Crown Inn, Broad-street, Birmingham. Tues., Jan. 11, 7.30 p.m.
BRISTOL
"Carburation," by L. J. Spencer. Western Centre. Grand Hotel, Bristol. Mon., Jan. 10, 7.30 p.m.
CARDIFF
"Skid-Resisting Properties of Roads and Tyres," by F. H. Kidd. South Wales Group. South Wales Institute of Engineers, Park-place, Cardiff. Thurs., Jan. 13, 7 p.m.
EDINBURGH
"Vehicle Suspension," by A. B. Sykes and J. Clifford. Scottish Centre. North British Station Hotel, Edinburgh. Mon., Jan. 10, 7.30 p.m.
MANCHESTER
Discussion on "The Development and Testing of Brake-Lining Materials." North-West Centre. Engineers' Club, Albert-square, Manchester. Mon., Jan. 10, 7.30 p.m.

Institute of Welding

LONDON
"Practical Control in the Welding of Alloy Steels," by I. C. Fitch. South London Branch. 2 Savoy-hill, W.C.2. Thurs., Jan. 13, 6.30 p.m.
DUNDEE
"Factors Affecting the Cost of Welding," by W. Waller. East of Scotland Branch. Dundee Technical College, Dundee. Fri., Jan. 14, 7 p.m.
EDINBURGH
"Factors Affecting the Cost of Welding," by W. Waller. East of Scotland Branch. Chamber of Commerce, Charlotte-square, Edinburgh. Wed., Jan. 12, 7 p.m.

Institution of British Agricultural Engineers

LONDON
"British Tractors in the United States," by Tom Gilling. Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Tues., Jan. 11, 2.15 p.m.

Institution of Civil Engineers

LONDON
"The Requirements of a Civil Airport, as Typified by London Airport," by B. E. Willett. Airport Division. Tues., Jan. 11, 5.30 p.m.
MANCHESTER
"Construction of the Haslingden and Walmersley Section of the Haweswater Aqueduct," by A. S. Bertlin. North-Western Association. Engineers' Club, Albert-square, Manchester. Thurs., Jan. 13, 6.30 p.m.

Institution of Electrical Engineers

LONDON
Discussion on "Atmospheric Pollution," opened by G. R. Peterson. Mon., Jan. 10, 5.30 p.m.
"Thermionic Valves of Improved Quality for Government and Industrial Purposes," by E. G. Rowe, P. Welch and W. W. Wright. Radio Section. Wed., Jan. 12, 5.30 p.m.
LIVERPOOL
"The Economic Selection of Cooling Towers for Generating Stations," by G. F. Kennedy and P. H. Margen. Mersey and North Wales Centre. Liverpool Royal Institution, Colquitt-street Liverpool. Mon., Jan. 10, 6.30 p.m.
LOUGHBOROUGH
"Heat Pumps," by J. A. Sumner. East Midland Centre. Loughborough College, Loughborough. Tues., Jan. 11, 6.30 p.m.
MANCHESTER
Faraday Lecture on "Courier to Carrier in Communications," by T. B. D. Terroni. North-Western Centre. Free Trade Hall, Manchester. Tues., Jan. 18, 7.30 p.m.
NEWCASTLE-UPON-TYNE
"Proving the Performance of Circuit-Breakers, with Particular Reference to Those of Large Breaking Capacity," by J. Christie, H. Leyburn and J. F. Bird; "A New Research Station for High-Power Circuit-Breakers," by J. Christie, H. Leyburn and R. W. Fenn; and "Design and Construction Features of a 275-kV Special-Duty Transformer Bank," by E. C. Rippon. North-Eastern Centre. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Jan. 10, 6.15 p.m.
SOUTHAMPTON
"Mechanical Aspects of Aircraft Generation Equipment," by W. R. Hinton. Southern Centre. The University, Southampton. Wed., Jan. 12, 6.30 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
"Some Aspects of Jig and Tool Design," by T. Williams. North-East Branch. Northern Architectural Association, 6 Higham-place, Newcastle-upon-Tyne. Mon., Jan. 10, 7.15 p.m.

Institution of Engineers-in-Charge

LONDON
Film on "Science of Industrial Water Treatment," introduced by G. G. Sindery. St. Bride Institute, Fleet-street, E.C.4. Wed., Jan. 12, 6 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Experiences in the Stabilisation of Ships," by Sir William Wallace. Tues., Jan. 11, 7.30 p.m.

Institution of Heating and Ventilating Engineers

BRISTOL
"Corrosion in Small Boilers," by J. C. Stainton. South-Western Branch. R.W.A. School of Architecture, Bristol. Tues., Jan. 11, 6.30 p.m.

Institution of Locomotive Engineers

LONDON
"Recent Trends in Electric Locomotives," by G. V. Dow, Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Wed., Jan. 12, 5.30 p.m.

Institution of Mechanical Engineers

LONDON
Four papers on "Vehicle and Road Lighting." Whole-Day Meeting of Automobile Division. Tues., Jan. 11, 10 a.m., 2.30 p.m. and 5.30 p.m.
Discussion on "Use and Misuse of Horizontal Borers." Industrial Administration and Engineering Production Group. Thurs., Jan. 13, 6.45 p.m.
James Clayton Lecture on "The Theory of Plasticity: Recent Achievements and Future Problems," by Dr. William Prager. Fri., Jan. 14, 5.30 p.m.
CHATHAM
"Main Propulsion Gas-Turbine Set for the Oil Tanker Auris," by B. E. G. Forsling. Southern Branch. Medway College of Technology, Maidstone-road, Chatham. Wed., Jan. 12, 7.30 p.m.
EDINBURGH
"Cutting-Tool Research in the United States," by Alex W. J. Chisholm. Scottish Branch. North British Hotel, Edinburgh. Fri., Jan. 14, 6.30 p.m.
GLASGOW
"Cutting-Tool Research in the United States," by Alex W. J. Chisholm. Scottish Branch. Royal Technical College, Glasgow. Thurs., Jan. 13, 7.30 p.m.
MIDDLESBROUGH
Thomas Hawksley Lecture on "Recent Studies of Metallic Friction," by Dr. F. P. Bowden. North-Eastern Branch. Cleveland Scientific Institute, Middlesbrough. Tues., Jan. 11, 6.30 p.m.
SOUTHAMPTON
"Mechanical Aspects of Aircraft Generation Equipment," by W. R. Hinton. Southern Branch. Institute of Education, Southampton University, Southampton. Wed., Jan. 12, 6.30 p.m.

Institution of Production Engineers

BLACKBURN
"Shell Moulding Process," by D. N. Buttrey. Preston Section. Crown Hotel, Market-place, Blackburn. Wed., Jan. 12, 7.15 p.m.
DONCASTER
"Optics Applied to Engineering," by M. H. Taylor. Doncaster Section. Danum Hotel, Doncaster. Tues., Jan. 11, 7 p.m.
LEEDS
"Unusual Products That Can Be Made from Tubes," by A. N. Attwood and L. C. Hackett. Yorkshire Section. Hotel Metropole, Leeds. Mon., Jan. 10, 7 p.m.
OXFORD
"Maintenance Matters," by G. C. Oram. Oxford Section. Town Hall, Oxford. Tues., Jan. 11, 7.30 p.m.
PETERBOROUGH
"Valid Incentives," by E. C. Gordon England. Peterborough Section. Campbell Hotel, Peterborough. Wed., Jan. 12, 7.30 p.m.
RUGBY
"Production of Steam Turbines," by D. Liebert and G. Haynes. Coventry Section. Church House, Rugby. Wed., Jan. 12, 7 p.m.

Institution of the Rubber Industry

LONDON
"Precision Seals," by J. A. Stephens; and "The Manufacture of Footwear," by Gilbert Crerar. Royal Society of Tropical Medicine and Hygiene, 26 Portland-place, W.1. Tues., Jan. 11, 5.30 p.m.

Institution of Sanitary Engineers

LONDON
Presidential Address. Caxton Hall, Westminster, S.W.1. Tues., Jan. 11, 6 p.m.

Institution of Structural Engineers

LONDON
"Gasholder Development and Design," by W. R. Garrett. Thurs., Jan. 13, 6 p.m.
LIVERPOOL
"Welding at Atomic Plants," by L. Rotherham. Lancashire and Cheshire Branch. Liverpool City College of Technology, Liverpool. Tues., Jan. 11, 7 p.m.

Junior Institution of Engineers

LONDON
"An Assembly-Line and Materials-Handling Technique in the Production of Heavy Vehicles," by W. J. Kease. Fri., Jan. 14, 7 p.m.

Newcomen Society

LONDON
"The Taylors of Southampton: Their Ships' Blocks, Circular Saw and Ships' Pumps," by the Late Dr. H. W. Dickinson. 4 Grosvenor-gardens, S.W.1. Wed., Jan. 12, 5.30 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
"Gas-Turbine Combustion Systems," by I. G. Bowen and W. Tipler. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Fri., Jan. 14, 6.15 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3. (Blackfriars 6178.)
Institute of Fuel 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. (SLOane 9851.)
Institution of British Agricultural Engineers, 24 Portland-place, London, W.1. (LANgham 3394.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Engineers in Charge, 100 Earlsfield-road, London, S.W.18. (BATtersea 1394.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Locomotive Engineers, 28 Victoria-street, London, S.W.1. (ABBey 6672.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of the Rubber Industry, 12 Whitehall, London, S.W.1. (WHItehall 5012.)
Institution of Sanitary Engineers, 118 Victoria-street, London, S.W.1. (VICtoria 3017.)
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S W 1. (VICtoria 0786.)
Newcomen Society, Science Museum, Exhibition-road, London, S.W.7. (KENsington 1793.)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne 1. (Newcastle 20289.)